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JUNE, 1935, TO MARCH, 1936
(Complete in ten numbers)

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VOLUME XXIV

JUNE, 1935 TO MARCH, 1936
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ERRATUM IN VOLUME XXIII (1934-1935)

Page 889, line 11 from top, "29.24 ± 0.88 days" should read "49.24 ± 0.88 days."

ERRATA IN VOLUME XXIV

Page 93, line 6 from top, "beyond" should be inserted after "road."

Page 95, line 3 from bottom, "THE BABUIO-BONTOC TRAIL" should read "THE BAGUIO-BONTOC TRAIL."

Page 136, lines 1 and 2 from top, "*Olethreutes schistaceana* Snell" should read "*Olethreutes schistaceana* Snellen."

Page 136, line 4 from top, "*Diatraea saccharalis*" should read "*Diatraea venosata.*"

Page 136, line 6 from top, "*Rhabdocnemis lineatocolis*" should read "*Trochorrhopalus strangulatus* Gyllenhal."

Page 354, line 20 from top, "road tests" should read "bench tests."

Page 797, lines 6, 7, 8, and 9 from top, "*Thesis presented for graduation, 1935, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 1105; Experiment Station contribution No. 485.*" should read "*Thesis presented for graduation, 1935, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 485; Experiment Station contribution No. 1105.*"

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PARATE

THE RESEARCHER IN THE NATURAL SCIENCES[1]

I propose to discuss this evening some of the situations and problems the researcher in the natural sciences has to face.

It should be recognized that in some degree scientists like poets are born and not made. But scientists have to be trained, and this training is usually long, tedious and exacting, but it is training not teaching, in that attempt is made to make the most of the innate characters in an individual.

Speaking of characters, an inquisitive spirit early revealed in a questioning attitude towards everyday occurrences and experiences, a seeking to fathom their whys and wherefores, never content to dismiss a subject until a satisfactory explanation is arrived at, right or wrong, naïve or profound, seems to be an inherent characteristic of students of nature. One must of course be a lover of nature and a close observer of things surrounding him. An open mind is a necessary attribute. Although one may often start a research project with a preconceived theory as to what the result will be, the true scientist faces the facts as they come to light, seeking plausible explanation for the unexpected events but always endeavoring to adjust his theories to the observed facts rather than adjusting the facts to his theories. It is at this juncture that the real scientist and the pseudo-scientist part ways. The first with a flexible view forges ahead, modifying as he goes along his views and modes of attack on the problem under study, the second drifts away further and further from the true path, distorting facts on the least possible plausibility to make them fit his preconceived theory.

A researcher is essentially not only creative but desires to give out information. He seeks to convey to others the results of his endeavor, and often he is instinctively a mentor, imparting to younger disciples his points of view, methods of study and procedure. This he does in part to speed up his work, as the mind travels faster than the hand, but in large measure from sheer delight in sharing with younger minds the rare satisfactions that are known

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[1] Excerpt from an address delivered by Dean B. M. Gonzalez, Vice-Chairman of the National Research Council of the Philippine Islands, at the closing dinner of the Third Philippine Science Convention, March 2, 1935.

General contribution from the College of Agriculture No. 490.

PHILIPPINE AGRICULTURIST, VOL. XXIV, NO. 1, JUNE, 1935.

only to one to whom the secrets of nature are gradually unfolded. Also he desires to insure the continuity of the work started. A scientist who neither has pupils nor publishes his results remains under the classification only through generosity.

Outsiders are inclined to look upon scientists as selfish, because they are often secretive during the period a piece of research is in active progress. But they are no more selfish than other humans in this respect. No artisan would rejoice to have his work imitated even before it is finished, nor would an orator wish to have his ideas taken away from him and used by one who happened to look over his manuscript before he himself had had a chance to voice them. All guard their ideas religiously until the stamp of their personality is imprinted on the product. Yet, it is the scientist that often suffers from this accusation of selfishness largely because the period of realization of an idea in science is long and therefore the chances of loss or leakage are greater. Also because a scientist often very trustingly imparts to others knowledge about his work as it unfolds.

Those who have traveled about the world can vouch for the open cordiality with which they have been received by fellow scientists. It amounts to almost a free-masonry this relationship of one scientist towards another in the same line. He opens his treasure house of knowledge and gladly gives away everything he possesses. But, of course, even among scientists there are off-colored ones who are only too prone to violate confidences and appropriate fragments of knowledge.

If added proof is desired of the unselfishness of the scientist it is revealed in the multitude of scientific discoveries and inventions yearly brought to the use of mankind, often without the originator receiving credit for it, and yet scientists are ever at their tasks, never being daunted by mere lack of recompense or recognition.

But scientists are human, and if they are resentful about this state of affairs, but still are not aroused to action, it is indeed to their credit.

There is one more characteristic that is either innate or soon develops in one adept in science, and that is the spirit of self-respect. This eventually follows an independent outlook on the phenomena of life and nature. The invariable and immutable consequence of cause and effect in nature which they face and observe every day turns them into cynics. They view the cavortings of politics and the by-play of human motives just as one more illustration of behaviorism in an animal species. At the same time, when it touches them personally, like one of the species, they are deeply affected. If one really understands scientists, he should not wonder why acts of injustice readily undermine their morale and finally turn them into dulled tools unequal to the tasks before them. Those in power finally come to the realization that exaltation and promotion among scientists when not based on merit react on the whole organization, which soon fails to function normally and ceases to give the desired results. It is then that they call scientists "sensitive" and "selfish".

There is no profession where merit is more readily accorded recognition than among natural science researchers, and the relationship among such workers, when based on mutual respect, is usually cordial if not fraternal.

The administrator, sometimes designated now as the Director of Research, but more often as head of the department, director, dean or president, has a distinct place in any research organization. He is a coordinator rather than a boss, an inspirer to greater and loftier endeavors rather than a taskmaster. The effective director takes a sympathetic interest rather than a critical attitude towards the personnel and the work of his staff. He must understand the peculiar idiosyncrasies of each and adjust his relations with them to meet varied personalities, very often only too pronounced among scientists. He stands ready to give effective aid when needed; it may take the form of new apparatus, or additional material or labor. And this often has to be done with no loss of time, otherwise valuable results in the offing may be lost altogether. For a director of research to fully understand the requirements of scientific workers, he must at some time have been one of them.

There is constant demand from the public for practical results in science, and this has led to the coining of the phrases "pure science" and "practical science". Where the demarcation line lies between the two no one knows. The fact is that the situation in science is pretty much like it is in a manufacturing plant. Preliminary steps tending to prepare the material have to be performed first. The mass gradually takes form as the distinct processes are completed until we have the finished product, which is the goal of our endeavors. The public understands well enough these necessary steps in a visible product. As in the making of a cake it is well known that wheat has to be grown first, and this milled into flour, etc. Or in the building of an automobile, the iron ore has to be mined first then smelted, alloyed, cast, tempered, etc. Yet in natural science there is a tendency for the public to be impatient about the time consumed on the preliminary processes that have to be gone through or often newly evolved. There is not a scientist who does not start a piece of research with the goal of making a discovery of such transcendent importance, of such far-reaching benefit to mankind as to startle and make the world sit up and take notice. All researchers aim for the larger prizes in science—renown, recognition, and material comforts for one's old age—although not all may readily admit it. Yet, how many finally obtain them? The important prizes in science are almost as scarce as the big purses in a lottery. In the same manner, however, as the thousands of losers make one winner possible, so in science the big discoveries, the monumental accomplishments, are built up largely from the results of the effort of many other scientists who have previously labored patiently and painstakingly over numerous small details.

STUDIES OF PHILIPPINE SOILS: I.

THE HISTORY OF SOIL SCIENCE IN THE ARCHIPELAGO [1]

ROBERT L. PENDLETON
Of the Department of Soils

INTRODUCTION

While the soil is the greatest natural resource of most regions of the earth, this is particularly true of the Philippines, a predominantly agricultural and forestry country. Yet in these Islands, as in most other parts of the world, in the development of scientific agriculture and forestry, pedology, or soil science is one of the last subjects to receive adequate and deserved attention. This is, in part, because too often the soil is taken for granted, but also it is because of the extreme complexity of the problems presented by the soil, and because of the failure of so many of the earlier methods of studying it. "Soil analysis", while impressive in producing tables of many figures, representing a vast investment of time and materials, and using expensive laboratory equipment, too often has not only added nothing to a real understanding of the soil and how to economically improve its crop producing power and conserve its fertility, but has actually led to erroneous ideas about soils. Thus, it has not been an unmixed misfortune that our Soils Department through paucity of laboratory equipment has been forced into the field to study soils at first hand; but more of this later.

In temperate regions of the earth great strides have been made in pedology in recent years, but in the Tropics the amount of research is still extremely limited. For our College instruction, in the absence of suitable texts dealing with tropical soils, we naturally lean upon books prepared for temperate Occidental conditions and based upon research under those conditions. We use such books in spite of the errors and misconceptions that are certain to arise from the use of such exotic material in the classroom and the laboratory; for we have not yet a sufficient amount of data upon our soils to serve as the substance of a text for Philippine conditions. We continue to borrow, translate, and adapt material from neighboring countries in the Indo-Malaya region, though with the realization that it cannot be a substitute for data collected here.

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[1] Experiment Station contribution No. 1024. Received for publication March 29, 1935.

Realizing that this great lack of data applied to all lines of tropical agriculture in the Philippines, the pioneers in this College wisely placed great emphasis upon the collection of data in all branches of agricultural science, and they devised our unusual and elaborate type of thesis procedure for all students graduating from this college. This emphasis upon theses was to stimulate as much as possible both faculty and students to contribute to this, as yet, far too small store of data.

The Soils Division, now the Soils Department, of the College of Agriculture, in the past eleven years has had a relatively continuous and consistent policy under the writer. There have now been completed over 55 theses by students majoring in soils. Because of reasons which will be more evident later in these papers, by far the greater proportion of these theses have not merited individual publication, though they have, of course, been kept on file. Some few theses under Doctor Aquino's advisership have been separately published.

A number of lines of activity followed by earlier thesis students have now been brought to a close or have been dropped in favor of more profitable lines of research, and there is hopeful anticipation of new lines of soil research soon developing in these Islands. It, therefore, seems that the present is an opportune time for summing up and placing on record the principal results of the past decade's work of the students and of the staff of the Soils Department.

Before discussing the status of soils research in the College, and the results which have been achieved here, it seems appropriate to briefly summarize the development of soil science in the Archipelago as a whole, for this was the foundation upon which we had to build.

DEVELOPMENT OF SOIL SCIENCE IN THE PHILIPPINES

It was early in its history that the Bureau of Agriculture commenced making soil surveys. Lent from the U. S. Bureau of Soils, Clarence W. Dorsey began a very important line of soil research when he surveyed the soils of the Batangas area, Luzon, a report of which he published in 1903. The tragedy for soil science in the Philippines is that this work was not continued, even in a very modest way. If this had been done, we would, today, have an invaluable mass of data for many lines of soil research and for the very practical needs of soil fertility maintenance and improvement. As it is, we are still completely ignorant of even the important soil characteristics over vast tracts of agricultural and forestry lands of the Islands. In addition to his Batangas survey, Dorsey spent some time travelling in the Philippines, and was able to record, although in the most general way, something of the character of the soils in the abacá regions, and at a number of widely scattered ports in the Archipelago. Some little attention was also devoted to the soils and agricultural conditions in La Union Province. Dorsey's successor, Sanchez, was given neither encouragement nor facilities, and to this day we have no soil survey organization for the Philippines. Apparently, the Bureau of Agriculture had little interest in the study of soils and made no attempts to encourage a soil survey.

The Bureau of Science, with its generous support for scientific work, and its excellent laboratory equipment, made the next contribution to the knowledge of the soils of the Philippines, when Walker (1910) presented his study of the sugar cane soils of the island of Negros. While representing much good work, too much emphasis was placed upon conventional mechanical and chemical analyses, and the report did not give much assistance in solving the fertility problems nor in aiding materially in soil conservation in the most important sugar producing island of the Philippines. Mechanical analyses were made according to Pratt's modification (1911) of the U. S. Bureau of Soils centrifugal method.

G. A. Graham in 1909 and 1910 made soil surveys of certain irrigation district projects under the Bureau of Public Works. These unpublished surveys have apparently been lost or destroyed by fire[2]. Cox and Argüelles have preserved one map and some of the data in their paper (1914).

Desiring to determine the principal characteristics of the soils producing the main Philippine crops, Cox presented (1911) the results of the analyses by the Bureau of Science of 180 samples from widely scattered localities in the Islands. These samples were analysed chemically. Of these, 31 were submitted to mechanical analysis, using a modified Schöne apparatus. In Cox's study as a whole, it is to be noted that he was following the very old but relatively fruitless method of attack upon soil classification and interpretation; namely, to attempt to characterize soils from the laboratory point of view, as contrasted with the modern and much more effective method of solving soil problems, that is by adequately studying the soil profile *in the field,* classifying and mapping the soils in the field, and then in the laboratory, from the study with the use of suitable methods, of well-selected representative samples, to interpret and explain the reasons for the soil phenomena and crop adaptations and responses observed in the field.

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[2] The writer was personally informed by A. D. Williams, Director of Public Works, and Manuel L. Roxas, Director of Plant Industry, that these surveys had been made and filed in manuscript form. The original copies were destroyed in the fire which burned the offices of the Bureau of Public Works in 1931; and the copies of the surveys in the Bureau of Agriculture, now the Bureau of Plant Industry, apparently had been destroyed in the process of cleaning out old files.

A subsequent paper by Cox and Argüelles (1914) presents in a similar way the results of the mechanical and chemical analyses of the soils of Batangas, Pangasinan, the Mountain Province, Cagayan and some other localities of Luzon. The chemical analyses were carried out on the hydrochloric acid extracts of the soils. As in the previous paper, the vast mass of data are presented in the hope that they will assist in the development of a soil classification based upon crops. The climatic factors are given and their controlling effect upon the crops is recognized, although there had not been appreciated the relationships which exist between the climate and the nature of the soils themselves.

In an endeavor to explain the variations in the flora on Mount Maquiling, Brown and Argüelles (1917) made a study of the soils of this mountain which adjoins our Campus. After making many determinations of the chemical characteristics of the soil, and of the water content of the soils, they concluded that it was the moisture content of the soil and not differences chemically that was the determining factor in the character of the flora.

To try to obtain a better understanding of the conditions surrounding the production of abacá fiber in the Philippines, Sherman (1928) working in the Bureau of Science, studied the chemical and physical characteristics of samples of abacá soils from Davao and the Bicol provinces. An innovation in his work is the attempt to rate the soils studied, as to the amount of each of the several nutrients as compared with the amounts in what he terms "standard Philippine agricultural soils", although it is not clear what data were used in establishing the standards.

In a study of the nitrifying power of some Philippine soils. Alicante (1927) dealt mostly with samples from Negros Occidental, with some soils from Batangas, the Mountain Province, Panay, and Rizal. His methods of sampling were a distinct improvement over the usual practices employed in the Philippines. From his results, Alicante concluded that nitrification in soils is an index of crop productivity. Another of his studies was a brief paper (1928) on the "aba-abo" soils of Negros Occidental, in which he pointed out the unsatisfactory water-holding capacity and low biological activity, while, except for a high acidity, a number of the chemical characteristics of the soil would indicate a higher fertility than farm practice had shown to exist. These studies, like all others on soils reported from the Bureau of Science, were primarily from the laboratory point of view. Such a viewpoint, while of distinct value, can never give the broad, comprehensive understanding of the soils of a region that a field survey and the making of a soil survey map can give. The most profitable and illuminating soil studies are those in which the soil survey field work, comprising the detailed studies of profiles and the making of a soil map, is followed by adequate sampling and the study of these samples by suitable physical, chemical, and biological methods in the laboratory and greenhouse, in order to interpret the soil profile and other field observations.

Some time after Alicante had begun work in the Bureau of Science, his services and certain facilities of the soils laboratory were placed at the disposal of the Philippine Sugar Association. This move, while it relieved the Government of salary and certain operating expenses and stimulated soil research, had two unfortunate results, as far as the Philippines as a whole were concerned. In the first place, the Association, being interested only in sugar cane production, limited the soil studies to sugar cane soils. Secondly, the Association being a private organization, saw fit to keep most of the results of the researches confidential. While in this the Association was fully within its rights, the public has been deprived of the use of the data obtained in those extensive studies.

While perhaps the local Sugar Association has not, on the whole, succeeded in maintaining the standards of field experimentation developed and carried out on an extensive scale in Java, yet Pritchett, Lee, Roxas,.and finally Bissinger, while in charge of the various phases of the field experimental work of the Association, have done excellent work in determining the fertilizer needs of sugar cane on soils in the more important sugar districts of the Philippines. In addition to the confidential data, a large amount of valuable information resulting from these studies is to be found in the Annual Reports of the Association, and in *The Sugar News.* While this line of study of the fertility deficiencies of sugar cane soils and methods for increasing the yield of sugar cane has undoubtedly been financially the most profitable single line of investigation of Philippine soils, for it has resulted in a far greater effectiveness achieved in the expenditure of money for cane fertilizers, it will not be further considered at this time.

SOIL RESEARCH IN THE COLLEGE OF AGRICULTURE

Before considering more definitely the studies of the soils themselves, let us briefly glance over earlier related studies in the College. While for a number of years there was no definite and specific research upon the properties and characteristics of the soils themselves, very early the study was begun of the response of various crops on the local soils, when fertilizing materials were applied.

Lowland rice fertilizers naturally received early attention, with Zamora (1911) reporting a pioneer pot experiment; Balangue (1916) recording an interesting and significant series of plot experiments; and Goco (1918) showing the significant effects of fertilizing upland rice as well as lowland. Abrajano (1923) demonstrated the good effects of green manure upon upland rice; Jimenez (1924) showed the generally unfavorable effects of manganese salts for rice; and Vibar (1926) conducted a more "practical" study of fertilizers for upland and lowland rice, using soil cultures in kerosene tins. He found lime increased markedly the yield of lowland rice, while decreasing that of upland, with sodium nitrate doing just the reverse. Ammonium sulfate was beneficial for both sorts.

Sugar cane fertilization also received early attention, with Tempongko (1913) making a crude beginning in plot tests. Considerably later, Mirasol (1918) in a relatively thorough experiment obtained rather definite results. But he recognized the wide variability of soils and distinctly cautioned against the application of the results even to other fields on our own Campus.

Other crops also received early attention: Albano (1915) studied the fertilizing of jute, reporting cow dung to be the best of those tried. Bacomo (1917) studied for over two years the responses of coconut seedlings to fertilizers and found early fertilization with ammonium sulfate to be effective, though he was not convinced that any fertilization of coconuts would be commercially profitable. Much later, Briones (1931) compared for a few months the effects of watering with various nutrient solutions young coconut seedlings planted in soil. Ammonium sulfate was good, and sodium chloride was distinctly stimulating.

Almost at the opening of the College, Copeland (1911) ably described caiñgins, and the threat that this form of cultivation held over tropical regions that allowed the practice to continue and to expand, especially at the expense of the valuable forests. Important as this problem was and is, too little attention has been devoted to the various factors involved. Quisumbing and Ocfemia (1914) studied chemical and bacteriological effects of burning grass or cogon lands. Panganiban (1915) measured the rates at which various soils, including those under cogon, nitrified various substances. Later, he reported (1923) upon the rates of decomposition of organic nitrogen in lowland rice soils, and the amounts of nitrogen in different forms as the moisture conditions change during the year.

The Department of Plant Physiology has been responsible for a considerable series of studies on the salt requirements of some of our important crops, though mainly of lowland rice in nutrient solutions, and often for periods not exceeding a month. Espino (1920) found the ammonium ion to be particularly effective for rice during the first three weeks. Trelease (1920), growing rice plants to maturity in soil cultures, furnished more satisfying evidence of ordinary nutrient needs. Trelease and Paulino (1920) also using soil cultures of lowland rice, while finding no correlation between certain fertilizers and yield, considered nitrogen as ammonium sulfate the best, ammonium nitrate, second, and calcium nitrate, third. Espino and Viado (1923) studied the nutrient requirements of abacá by growing the plants in soil in pots, to which solutions of various nutrients were added. Espino and Juliano (1924) in a very ingenious manner tested the rates at which roots of mature coconut palms take up various nutrient solutions, depending upon the time of day, and other variable conditions. Espino and Estioko (1931), working with solution cultures of young rice, demonstrated that nitrogen should be added to such cultures in both the ammonium and nitrate forms. Espino and Palisoc (1931), working with similar cultures, found that the plants would tolerate relatively large quantities of magnesium sulfate and argued that it is this compound as such that is important in rice nutrition.

The Department of Agricultural Chemistry has continued to do much good work on certain phases of soil reaction, soil analyses, base exchange, etc. The work of Deming, Lava, Galvez, King and others will be more definitely referred to in subsequent papers of this series. A considerable number of unpublished theses recording work done in the departments of Agricultural Chemistry and Agronomy, such as those of Aragon, Cayabyab, Marfori, and Ureta, have not been referred to at all in the brief survey above.

This discussion of what has been done by the College of Agriculture in plant nutrition, fertilization, and the study of certain factors affecting the fertility of soils, is in no sense complete, and is given more to show the direction in which, during the earlier years of the College, studies involving the soil were made. In those early years there was not even a separate course in soils, much less a separate department for the study of the soil and for specialized instruction therein. It was felt that there was not enough known about tropical soils, particularly in the Philippines, to make such a course worth while.[3]

It was in the Agronomy Department that Dr. Jose J. Mirasol assumed in 1920 the direction of soils instruction and research. It was not long before other University activities diverted Doctor Mirasol's attention from soils work; when he gave it up, A. S. Argüelles of the Soils Laboratory, Bureau of Science, carried on a lecture course in the College until the writer assumed charge of the Soils Division in 1923. It was not until July, 1930, that the separate Department of Soils was established.

It was early evident that only in the course of time could the knowledge of Philippine soils be sufficiently developed to make classroom and laboratory instruction satisfactory. The soils of the Philippines had not been studied systematically, there were almost no soil surveys, and worst of all, there were practically no funds available for travelling to study soils in the field—the one place where they must first be studied if an adequate understanding of them is to be developed. There was in the College no going soil laboratory, and the modest nucleus of equipment had suffered sadly. Plot and field studies of plant response to fertilizers and other soil treatments, while of much value in quickly obtaining an empirical knowledge of soil management practices, were beset with such difficulties that very little work along this line was possible. At this time, the end of 1923, the Soils Division staff consisted of the writer and one assistant, Fermin Gamboa.

However, there were some things which we did have to work with: the Campus and all the surrounding country were covered with soils of recent volcanic nature and most interesting to study in the field. But with the several large lecture classes to care for, field work was somewhat limited.

Very fortunately the late Dean Baker was generous in the extreme in not only allowing but encouraging travel to study soils anywhere in the Philippines, provided the writer could raise his own funds for the purpose! Official time was granted for some of the trips, when accrued leave did not suffice. Thus, it was that the soil survey maps and reports were made and published of the Silay-Saravia and La Carlota districts, Occidental Negros. (Pendleton 1927, 1931). For the Philippine Sugar Association a reconnaissance soil survey was made of most of the province of Occidental Negros; and surveys have been made for private parties in Iloilo, Mindoro, Laguna, La Union, and Ilocos Sur provinces. The Bureau of Forestry made possible a study of the soils of the Bokakeng project, Baguio; while for the Bureau of Education soil studies were made of farm school lands at Muñoz and Trinidad. Official time at personal expense was allowed for a study of soil research facilities and accomplishment in Japan and Formosa. Attendance at the Science Congress and the International Sugar Conference in Java, 1929, and contacts with the pedologists and their research facilities and accomplishments revealed the wealth and value of the soil literature on tropical soils in the Nederlandsch language. Later, the University generously made it possible for the writer to acquire some knowledge of that language. Of the numerous translations which have been made, several have appeared in print; world wide recognition has been accorded the translation of Doctor Mohr's work on tropical soils. For parts of two years the writer was absent on leave without pay in China where he was aiding in the development of soil survey.

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[3] This sentence is the substance of a remark made to the writer by the first Dean of the College, Dr. Edwin Bingham Copeland.

All this activity in field work in soils, in addition to maintaining the routine of administration and instruction of college classes in the lecture room, laboratory, and field, has been far from a one-man task. Fermin Gamboa, Dionisio Aquino, and the late Tomas Bandong served faithfully in the early years, while numerous student assistants have contributed much toward the accomplishments which will be recorded in subsequent papers. Thesis students have accomplished a vast amount of work. The share of credit due to the several members of the staff will appear later in connection with the presentation of the results embodied in the different theses. In 1926, Aquino went on his own initiative to Ames, Iowa, for graduate work in soil microbiology. 1928, Professor Inocencio Elayda, formerly of the Extension Division of the College, was deputed by the Board of Regents, to assist in the work of the Soils Division. In 1930, Doctor Aquino returned and has since been in charge of the instruction and research in soil microbiology. Professor Elayda retired from active service in 1934.

For nearly ten years the Soils Division/Department was housed in a frame building constructed by "repairing" two small adjacent structures, the greenhouse and the silkworm house. In May, 1933, upon removal of the College of Veterinary Science from our Campus to Manila, the Soils Department was assigned the old Veterinary building and some adjacent outbuildings. This change has considerably improved our laboratory and office facilities.

CONCLUSION

As an introduction to the presentation, in a series of short papers, of a considerable amount of data incorporated thus far in unpublished theses on soils of the Philippines, there has been recalled in this paper something of the early studies of soils, both by other branches of the Insular Government and more particularly by the College of Agriculture. The historical development of the Soils Division, now the Department of Soils, of the College of Agriculture has been outlined.

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THE RED SCINDI CATTLE IMPORTED BY THE COLLEGE OF AGRICULTURE, UNIVERSITY OF THE PHILIPPINES[1]

VALENTE VILLEGAS
Of the Department of Animal Husbandry

WITH TWO TEXT FIGURES

Through the intervention and courtesy of the Bureau of Animal Industry, the College of Agriculture made its first direct importation of live stock from India, which consisted of one bull and three cows of the Red Scindi breed of dairy cattle. The animals arrived in Manila on December 8, 1933 by the *S. S. Benvenue* under the charge of an Indian caretaker, Khairmahomed Abdulrehman Dahari. The cattle were shipped from Karachi, Sind, India on November 11, 1933, on the *S. S. Havre Maru* of the Nippon Yusen Kaisha from which boat they were unloaded at Singapore on November 26, 1933, and loaded on the *S. S. Benvenue* on December 3, 1933. Altogether, the animals were on the sea for 22 days.

These four animals are the second shipment of the Red Scindi cattle into this country. The first consignment consisted of one bull and seven cows which reached Manila on February 22, 1932. The third shipment consisting of two bulls, 36 cows and 16 calves arrived on October 6, 1934. The first and third importations were purchased by the Bureau of Animal Industry. These animals were also shipped from Karachi.

It may be of interest to know that importing cattle into the Philippines is not a rapid transaction. In the acquisition of the College animals the first steps were taken on April 20, 1933. The animals arrived on December 8, 1933, the total period required covering a little over seven and one-half months.

Nor, is the importing a simple two-man deal. Besides Director Victor Buencamino of the Bureau of Animal Industry who negotiated for the purchase of these animals, the College of Agriculture is indebted to the American Consul, Joseph G. Groeninger in Karachi for taking the formal and practical steps leading to the selection for this College of the best animals available of the Red Scindi

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[1] General contribution from the College of Agriculture No. 491. Received for publication February 6, 1935.

breed. Mr. Lloyd E. Riggs, American Vice Consul at Karachi, with the assistance of Mr. C. S. G. Haji, G.B.V.C., Veterinary Inspector of the Lower Scindi Circle, Hyderabad, India, personally undertook to select the animals at the semi-government farm at Mirpurkhas. It should also be noted, here, that the Chief Agricultural Officer in Sind is also to be credited, in part, for whatever success this College may have with these animals. He was most liberal and generous in according Messrs. Riggs and Haji freedom in choosing for the College superior stock in the herd under his charge. According to Mr. Groeninger, "he gave orders to the officials at the stock farm to offer only the finest of the herd for selection by Mr. Riggs as he wished the cattle sent... [here] to do full credit to the reputation of the Red Scindi breed". The commercial side of the negotiations was carried out by Cox and Kings, Limited.

Source of animals

Judging from the conformation, performance and pedigree of the animals, the College of Agriculture should take pride in having procured individuals of high quality. Considering that at the time of their purchase the demand for this breed by Central and South American countries was great, it was, indeed, fortunate that these fine animals were secured for this College. These animals were part of the stock kept at the Willingdon Farm at Malir which owned the best herd of Red Scindi cattle in India. As a retrenchment measure the Willingdon Farm was discontinued but eighty selected head were taken to the semi-government farm at Mirpurkhas. The rest were sold at public auction and to *zamindars* (landowners), stock raisers and dealers.

Pedigree and performance of animals

As to names, the animals imported by the College were listed as Sawan for the bull, and Isabella, Vallayati and Takli for the cows. Sawan is dark red in color, rugged, symmetrical and very masculine in appearance and behavior. His present weight is 592.4 kilograms. Among the cows, Vallayati is the most beautiful in appearance although her head is rather masculine. She weighs 381.0 kilograms. Isabella, the oldest of the three cows, is fair in size and conformation, and weighs 324.8 kilograms. Takli weighs 331.1 kilograms. She has the poorest conformation, being defective especially at the rump which is sloping. Each cow has a well-developed udder. The cattle are uniformly blood red in color which makes them attractive in appearance.

It is evident that the most valuable animal in this importation is Sawan. Not only has he a very good pedigree but as a performer he ranks high. He was born on July 13, 1929, so that he has many years ahead of him as a breeding animal. This bull was sired by the bull Imam which was out of the cow Iris, the latter having given 3411.4 liters of milk in 278 days, her best lactation, and six calves. Sawan's dam was Sugin which had a record of 2176.5 liters in her longest lactation of 343 days. Sugin was sired by Rupoo; her dam was Syain which not only produced 3184.2 liters in her best lactation but also gave 11 calves in 12 years.

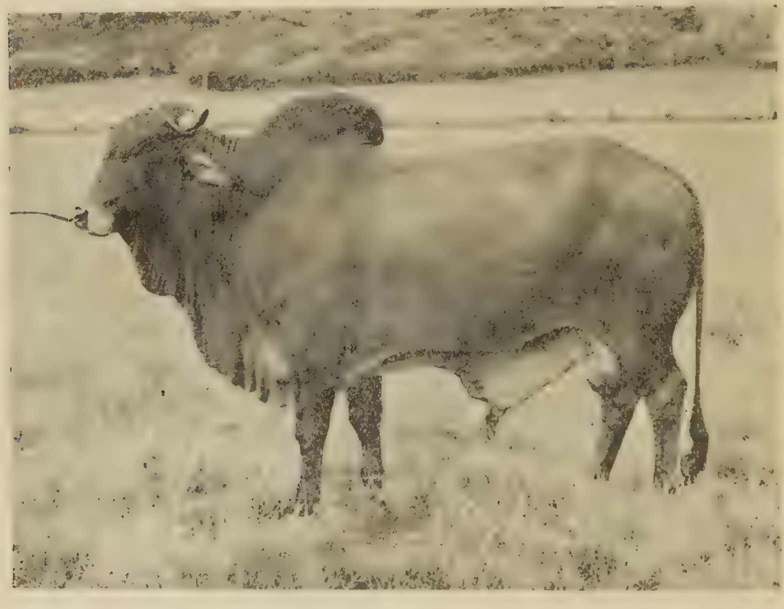

Fig. 1.—Sawan, the Red Scindi bull. Note his superior size and masculine features as indicated by the ruggedness of his head and well-developed hump.

Isabella being the oldest of the cows, brought a milk record with her. She was born on November 1, 1928, and had had two calves. In her best lactation she gave 2699.5 liters of milk. This cow was sired by Kerman, a progeny of Rupoo, the grandfather of Sawan. Kerman's dam was Karachi, a cow with 10 calves to her credit and a production record of 2207.3 liters in her best lactation. The mother of Isabella was Indra with a record of 2965 liters of milk in her best lactation. Indra is out of Iris, the grandmother of Sawan on the sire side.

The second cow, Vallayati, was born on February 25, 1930. Her sire was Imam, the dam being Bhoor II. Sawan and this cow are, therefore, half-brother and sister. Bhoor II gave 2641.4 liters of milk in her best lactation period. She won first prize in many Indian cattle shows, principally in Ahmedabad, Allahabad and Bangalore. Bhoor II's sire was Rupoo making Vallayati the granddaughter of this bull, the same relationship that Sawan and Isabella bear to this bull.

The youngest of the animals, Takli, was born on August 26, 1930. She is also a granddaughter of Rupoo on the dam side. Her dam, Mariam, has a record of 2855.8 liters in her best lactation; Thul, the mother of this cow, gave 1760.9 liters in her best lactation period and had six calves to her credit. The father of Takli was Dawood which was sired by Sheik. Dawood's dam, Daisy produced in her best lactation 2349.5 liters of milk. Takli was bred by Malcolm, at present the herd bull at the semi-government farm at Mirpurkhas; Isabella and Vallayati were bred to Sawan. All the cows have delivered full term calves, Vallayati has produced two calves and Isabella and Takli one each since their arrival.

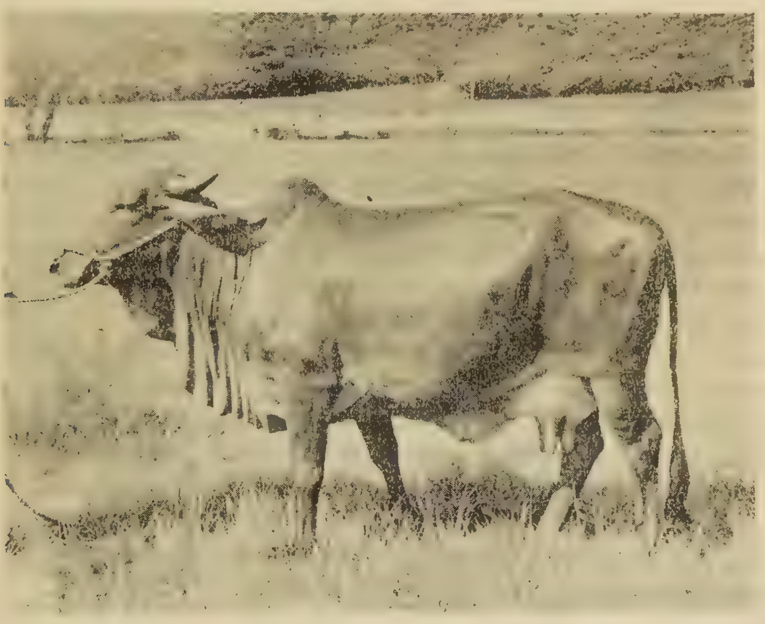

Fig. 2.—Vallayati, showing good size, smooth lines and large and well-formed mammary gland.

Animals tested for tuberculosis and tick fever

Before shipping, all the animals in this importation were tested for tuberculosis by M. Mohey Deen, M.R.C.V.S., Superintendent of the Civil Veterinary Department of Sind and Rajputana, India, and all were found free from the disease. They were also tested for tick fever, the results being negative. The animals were not examined for contagious abortion, because this malady is not known in Sind, hence, the animals were presumed to be free from it.

A statement certifying the potency of the bull Sawan accompanied him. Also, a demonstration proving his potency was made before Messrs. Riggs and Haji. Sawan was being used for breeding purposes at Mirpurkhas at the time he was purchased for this College.

Expenditures incurred in importing the animals

Altogether it cost the Philippine government ₱4,080.19 to acquire these animals, making the cost of each ₱1,020.05. The original price of the four head of cattle was ₱724.66, which is only 17.8 per cent of the total disbursements. Other important items which increased the cost are the following: The veterinary fees for performing the tuberculin tests were ₱37.23. The cost of traveling insurance of the animals was ₱144.94. The animals were shipped in four shipping stalls costing ₱362.33. The freight charges on the train from Mirpurkhas to Karachi and on the boat from Karachi to Manila amounted to ₱663.93, representing 91.6 per cent of the original price of the animals. At Karachi, fees were charged for port dues and certification, totalling ₱108.70. Other expenses at this port included ₱36.23 in fees to steamer personnel, and agency fees and miscellaneous expenses amounting to ₱181.16. Drugs costing ₱19.29 were taken along. Feed for the animals on the way cost ₱121.11. In Manila a customs duty of ₱40.00 was paid. The American Express Co., Inc. charged ₱597.64 for import expenses. The expense account of the caretaker which included his wages, transportation and incidentals was ₱381.34. The transportation and incidental expenses of Vice-Consul Riggs amounted to ₱310.65. Also, an appreciable sum amounting to ₱180.98 was paid for cablegrams and radiogram used in the transactions.

Adaptability of animals to Philippine conditions

No conclusive statement can be made at this time on the adaptability of this breed to Philippine conditions. Preliminary observations, however, seem to indicate that these animals, like other

Oriental breeds of live stock, are finding themselves "at home" in the Islands. The animals at the College of Agriculture subsist well on local feeds and from the time of their arrival they have gained in weight. Breeding has taken place normally, and the calves are growing well. All the cows have accepted the bull soon after delivery. Vallayati has delivered two calves with an interval of 350 days between them. The milk production has been very satisfactory. The performance so far shown by the College Red Scindi cows indicates that this breed bids fair to play an important rôle in the advancement of the dairy industry in the Philippines.

CYANOPHORIC PLANTS OF THE MAQUILING REGION: V[1]

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AND
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The list of cyanophoric plants of the Maquiling region made by Herbert (1922), Juliano (1923, 1933), and Peralta (1928) is by no means complete. The present report is an addenda to those four lists. Numerous herbs, shrubs, and even trees, some of which are of much economic importance to foresters as well as to farmers were tested, and those which were found to possess prussic or hydrocyanic acid, but had not been included in any of the reports mentioned above are reported in this list. The simple modified Guignard test as described by Herbert (1922) was employed in this study. Nearly all of the tests were carried out by the junior author while taking a course in Ecology of Pastures and Weeds under the direct supervision of the senior author at the College of Agriculture during January, February and March, 1934. The scientific names as well as the vernacular names of each species here included were taken from and checked with the use of Merrill's *An Enumeration of Philippine Flowering Plants* (1923-1926).

APOCYNACEAE

Wrightia laniti (Blanco) Merr. (laniti): Positive in leaves; negative in barks of stem and root.

BOMBACACEAE

Ceiba pentandra (Linn.) Gaertn. (buboi, kapók): Positive in barks of stem and root, and flowers.

BURSERACEAE

Canarium ovatum Engl. (píli): Trace in pulp of fruit; positive in leaves and barks of stem and root.

COMBRETACEAE

Terminalia catappa Linn. (talísai): Positive in bark of stem and leaves.

COMPOSITAE

Elephantopus scaber Linn. (dila-dila): Trace in roots, stems and leaves.

Tithonia diversifolia A. Gray: Trace in roots and flowers; positive in stems and leaves.

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[1] Experiment Station contribution, No. 1025. Received for publication, March 11, 1935.

CYPERACEAE

Fimbristylis annua (All.) R. & S.: Positive in roots; trace in fruits; negative in stem.

DIPTEROCARPACEAE

Parashorea malaanonan (Blanco) Merr. (lauaan, malaanonang): Positive in leaves and barks of stem and root.

EBENACEAE

Diospyros ahernii Merr. (ánang, talang-gúbat): Trace in leaves and bark of stem.

Diospyros discolor Willd. (kamagón, mabólo): Trace in leaves; positive in barks of stem and root.

EUPHORBIACEAE

Antidesma bunius (Linn.) Spreng. (bignai): Positive in leaves and barks of root and stem; negative in fruits.

Homonoia riparia Lour. (agúkok, lumanái): Trace in bark of stem; negative in leaves.

Macaranga tanarius (Linn.) Muell.-Arg. (binuñga): Positive in barks of stem and root; negative in leaves.

Manihot glaziovii Muell.-Arg. (Ceara rubber): Positive in barks of stem and root; negative in leaves.

Sapium luzonicum (Vidal) Merr. (balakát-gúbat): Positive in leaves and barks of stem and root.

GRAMINEAE

Andropogon rufus Kunth: Trace in roots and stems; positive in leaves and flowers.

Panicum repens Linn. (luya-luyáhan): Positive in roots; trace in fruits; negative in stems and leaves.

Pennisetum merkerii (merker grass): Trace in roots; negative in leaves, stem and fruit.

Pennisetum purpureum Schum. (napier grass): Positive in leaves; trace in flowers; negative in roots and stems.

Tricholaena rosea Nees. (natal grass): Trace in stem; positive in leaves and flowers; negative in roots.

GUTTIFERAE

Garcinia lateriflora Blume (maladambo, taklánganák): Positive in barks of stem and roots; negative in leaves.

LABIATAE

Hyptis capitata Jacq. (kambali, kombar-kombáran): Positive in roots, stems and leaves.

LECYTHIDACEAE

Planchonia spectabilis Merr. (lamog, malapútat, malaúban): Trace in leaves; positive in barks of stem and roots.

LEGUMINOSAE

Albizzia acle (Blanco) Merr. (akle): Positive in barks of stem and root; negative in leaves. Kalaw and Sacay (1925) did not find any trace of hydrocyanic acid in leaves, barks and roots of this plant collected from Batangas and Bulacan.

Bauhinia monandra Kurz. (cinco llagas, frigon): Trace in leaves; positive in barks of stem and roots, and fruits.

Cassia siamea Lam. (acacia): Positive in roots, stem and leaves.

Entada phaseoloides (Linn.) Merr. (bagógo, gógo): Positive in barks of stem and roots. Kalaw and Sacay (1925) also did not find any trace of prussic acid in leaves, bark and fruits of this plant found in Batangas and Bulacan.

Peltophorum inerme (Roxb.) Llanos: Trace in leaves; positive in barks of stem and roots.

Pterocarpus vidalianus Rolfe (narra): Trace in leaves; positive in barks of stem and roots.

Samanea saman (Jacq.) Merr. (acacia, palo de china): Trace in leaves and bark of root; positive in bark of stem.

Sesbania grandiflora (Linn.) Pers. (katurai): Positive in barks of stem and root; trace in fruit; negative in leaves.

Tamarindus indica Linn. (sampálok); Positive in leaves and barks of stem and root, and fruits.

Wallaceodendron celebicum Koord. (banúyo): Trace in leaves; positive in barks of stem and root.

MARANTACEAE

Donax canaeformis (Forst. f.) K. Schum. (bambán): Trace in leaves, stem and root.

MALVACEAE

Bombycidendron vidalianum (Naves) Merr. (lanútan): Positive in barks of stem and root; negative in leaves.

Sida retusa Linn. (eskoba, eskóbang-bilog): Trace in roots, stem, leaves and fruits.

MELIACEAE

Sandoricum koetjape (Burm. f.) Merr. (santol): Positive in leaves and bark of stem; trace in bark of root.

Toona calantas Merr. & Rolfe (kalantas): Trace in leaves; positive in barks of stem and root.

MORACEAE

Allaeanthus luzonicus (Blanco) F.-Vill. (himbabá-o): Positive in barks of stem and root.

Artocarpus blancoi (Elmer) Merr. (antipólo): Positive in barks of stem and root.

MUSACEAE

Musa textilis Nees (abaca): Trace in leaf blade and fruits; positive in leaf sheath.

MYRTACEAE

Eugenia similis Merr. (makaasim, malarúhat, malarúhat-puti): Trace in leaves; positive in barks of stem and root.

Eugenia sp.: Positive in leaves and barks of stem and root.

NYCTAGINACEAE

Pisonia umbellifera (Forst.) Seem. (anuling): Trace in barks of stem and root; positive in leaves.

OLACACEAE

Strombosia philippinensis (Baill.) Rolfe (tamayuan): Positive in barks of stem and root; negative in leaves.

PALMAE

Caryota cumingii Lodd. (pugahan): Positive in root and stem; negative in leaves.

PANDANACEAE

Pandanus luzonensis Merr. (alasás, pandán): Trace in leaves; positive in stem and root.

PONTEDERIACEAE

Monochoria hastata (Linn.) Solms (gabi-gabíhan): Trace in roots; negative in stem, leaves and fruits.

RUBIACEAE

Psychotria luçoniensis (Cham. & Schlecht.) F.-Vill. (katagpóng-gúbat): Trace in leaves and fruits; positive in barks of stem and root.

SAPINDACEAE

Nephelium mutabile Blume (bulála): Positive in leaves and barks of stem and root.

SOLANACEAE

Brunfelsia americana Linn.: Trace in leaves and flowers; positive in barks of stem and root.

Nicotiana tabacum Linn. (tabaco, tobacco): Trace in root, stem and leaves.

Solanum melongena Linn. (eggplant, talong): Trace in leaves, root, stem, and fruit.

STERCULIACEAE

Pterocymbium tinctorium (Blanco) Merr. (talúto): Positive in leaves and barks of stem and root.

Theobroma cacao Linn. (cacao): Positive in leaves, and barks of stem and root; trace in young fruits.

TILIACEAE

Diplodiscus paniculatus Turcz. (balóbo): Positive in barks of stem and root.

VERBENACEAE

Callicarpa cana Linn. (palis, tigau): Positive in roots; trace in stem; negative in leaves.

Clerodendron intermedium Cham. (kasupañgil): Trace in leaves; negative in stem.

Vitex parviflora Juss. (mulaúin, moláve): Positive in leaves and barks of stem and roots. Kalaw and Sacay (1925) did not find this acid in fruits from plants collected from Batangas and Bulacan.

VITACEAE

Leea aculeata Blume (hára, sipit-kahig): Positive in barks of stem and root; negative in leaves.

ZINGIBERACEAE

Hedychium coronarium Koenig (kámia): Trace in rhizome; negative in leaves.

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BUD DIFFERENTIATION IN SMUDGED MANGO TREES[1]

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WITH FOUR PLATES

The smudging of mango trees, a laborious practice common in some regions in the Philippines, is designed to produce fruits out of season so as to command better prices. The smudging is usually done for a period ranging from one to a few weeks, or until the inflorescence or floral clusters are well developed. There is a common belief among farmers that leaves will develop instead of flowers if smudging is stopped before the floral clusters become visible. Whether or not this belief is supported by fact can be determined only by accurate knowledge of the differentiation of the terminal buds of mango trees during the smudging operation. It is hardly probable that a bud well ahead in its development into a floral cluster would revert into a vegetative bud if the stimulus were removed.

It was one of the aims in this study to find out the number of days of smudging necessary for the initial growth and development of the inflorescence.

There is no available literature on bud differentiation of the mango. Gonzalez (1923) found a correlation between the condition of the leaves and the response to smudging. He also found that there is a positive correlation between the degree of rise in temperature during smudging and the number of days necessary to force out the buds. Later, the same author (1933) gave evidence to show that heat, rather than the products of combustion, is responsible for floral bud differentiation. Borja and Bautista (1932) differed from Gonzalez; they expressed the belief that it is the "suffocating effect" of the smoke that causes flowering, and not the heat.

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MATERIAL AND METHODS

Four mango trees in the Orchard of the Agronomy Department, College of Agriculture were used in the study reported in this paper. Two of the trees belong to the Indian seedling races imported from Hawaii, and for convenience they will be designated in this paper as Indian No. 1 and Indian No. 2. The third tree is a Pico and the fourth, a Carabao. The condition of each tree prior to smudging is described in the following paragraphs.

Indian No. 1 is a grafted tree about 15 years old, the scion having come from a chance seedling. At the time smudging was begun, the buds were in resting condition and the leaves were brownish. This tree has been fruiting regularly for several years.

Indian No. 2 is about 7 years old and is also a grafted plant of the same variety as Indian No. 1. The leaves were still immature at the time this work was started. This tree bore about 50 fruits when it was four years old, but has borne none since.

The Pico tree is estimated to be about 20 years old. It was in a condition of growth similar to the Indian No. 1, when smudging was begun. It is an irregular bearer, the last fruiting being in 1931.

The Carabao mango is about 12 years old and has never produced any fruit. It was in a dormant condition when smudging was begun and, in general appearance, was similar to the Pico.

Smudging was done day and night from November 4 to December 11, 1933. Tree trunks, branches, leaves, corn stover, and grass were used for smudging fuel. To produce continuous smoke throughout the night, rice straw was heaped over the large pieces of burning wood at twilight. At least two smudges were built under each tree. Straw screens were used to direct the smoke to the crown of the tree. Smudging was stopped when the flower buds appeared and became clearly visible.

To obtain comparable results and to be able to follow the development of the buds during the smudging, from 80 to 100 buds of about the same size, shape and appearance on each tree were tagged. During the smudging period five representative tagged buds were collected daily from each tree and were brought to the laboratory for proper macroscopical and microscopical study.

Slabs were cut off from two opposite sides of the buds leaving a median section only about a millimeter thick. These buds were then fixed and killed in formalin-acetic-alcohol (70 per cent) prepared according to the formula given by Chamberlain (1932). The material was treated as usual and embedded in paraffin. Sections 10 to 15 micra thick were cut and most of these were stained with Delafield's haematoxylin-safranin.

OBSERVATIONS

Macroscopical

Description of shoot bud. The apical, or the shoot bud in its dormant stage is somewhat conical in shape, set just above the bases of the terminal well developed leaves that represent the last flush. This bud is usually black, its size depends on the girth of the branch. It is covered with scales of various sizes and shapes, which are imbricate and spirally arranged on the axis (pl. 4, fig. 18). The outermost scales are usually tough and hard, with prominent apical protrusions, and are conspicuously ridged on their dorsal or nether sides (pl. 4, fig. 20-26, 39-42). The tips of these outer scales usually diverge from the center of the bud, but sometimes are held vertically. All the exposed portions of these outer scales are black, whereas their ventral or upper sides are usually greenish. Of the inner imbricate scales, only their exposed apices are black; these scales tightly clasp one another and together protect the central meristem from drying and mechanical injury (pl. 2, fig. 7), and those which they subtend in their axils (pl. 1, fig. 1).

When growth begins, the outer scales are usually shed first owing, perhaps, to the enlargement of the apical meristem as well as the buds from the axils of the inner scales (if floral clusters are developed); the inner scales are shed later.

Bud scales. At first glance, the bud scales appear to be simple, vaginate structures with no trace of distinct laminae, such as characterize the foliage leaves. A careful examination, however, show that every bud scale terminates during its development in a minute protuberance at its apex (pl. 4, fig. 20). This protuberance is morphologically equivalent to the lamina of the normal leaf (pl. 4, fig. 19, 36). Actually, the bud scale is distinctly separated into two elements; namely, (1) the broad, sheathlike portion forming the bulk of the bud scale, and (2) an apical laminar primordium, the development, form, and size of which vary with the relative positions of the bud scales on the shoot bud.

The sheath.—The sheath, or the vaginate portion of the bud scale, shows progressive changes in size and shape (pl. 4, fig. 20-35, 39-52), and even in color, depending on its position on the shoot bud. The first outer bud scales are usually small, varying from

3 to 5 mm. in height, and from 4 to 5 mm. in width at their basal portions. They are usually triangular in form (pl. 4, fig. 20-29), blackish on their exposed portions, green to pale green on their inner surfaces, margins thinner than their median portions, covered with unicellular to multicellular uniseriate trichomes or hairs (pl. 2, fig. 7) which are usually shed at some time in their history,—trichomes near the apical protrusion and those at the margin always persisting. Their dorsal sides are distinctly ridged or keeled, terminating in distinct prolongations at their apices, which are more or less terete, tapering towards the tips, and covered with distinct, brownish black or hyaline shaggy coating of unicellular to multicellular uniseriate trichomes.

The subsequent bud scales show some definite changes in size and shape, depending on what is to be formed from the bud during later development. While definite shapes of bud scales are associated with shoot buds which may develop floral clusters in contradistinction to those which form only foliar leaves, the correlation does not always hold true, that is, if differentiation between the two shoot buds mentioned is based only on external appearance of the bud scales. However, the divergence in form and shape of the inner bud scales on these two types of shoot buds is sometimes so great as to warrant their study in detail.

Foliar shoot buds.—Of the shoot buds which developed only leaves, that the writers examined during smudging, in a majority the inner imbricate bud scales subtended by the outer bud scales described above, show definite forms and changes in size acropetally. These inner bud scales become increasingly thinner, a character perhaps associated with the decreasing amount of surface exposed to the air. Thus, the lower and outer imbricate bud scales which are shorter than the shoot bud are wholly exposed, while the inner bud scales remain enclosed, and have only their tips exposed. These inner scales emerge only after growth has been started for some time. They are usually ovate deltoid (pl. 4, fig. 25-29) to broadly obovate (pl. 4, fig. 30-31), becoming oblong inward (pl. 4, fig. 32-34). The laminar primordia correspondingly decrease in length, becoming shorter and shorter until the transition bud scales are reached (pl. 4, fig. 35). The bases of their sheaths become narrower in the most interior bud scales (pl. 4, fig. 34), while the lengths increase so that the last of the inner bud scales usually possesses somewhat elongated elliptical sheath.

In the transition form the bud scales may be only one or two in number, though in some cases, several, depending on the size of the shoot bud. This bud scale shows a decidedly narrow sheath (pl. 4, fig. 35) which undergoes a marked decrease in width, and extreme elongation. Simultaneously, its laminar primordium becomes considerably lengthened, and on its adaxial side it bears a slight, winged outgrowth as the first sign of laminar formation. Subsequent transition bud scales may show a progressive development of the lamina until the true leaf primordia are reached, where distinct laminae are easily discernible even with the unaided eye (pl. 4, fig. 19, 36).

The foliar shoot buds usually present a very marked elongation, and the tips of the juvenile scales and leaf primordia were never observed to form a flat cone (pl. 4, fig. 19), a character usually observable on shoot buds which develop floral cluster (pl. 4, fig. 36-37). This character is prominent; the writers are of the opinion that it may be utilized in distinguishing foliar shoot buds from the floral shoot buds.

Floral shoot buds.—Study of numerous floral shoot buds (buds which develop only floral clusters) revealed very interesting results. The outer bud scales of these shoot buds show no marked divergence in shape and size from those found on foliar shoot buds. These scales are usually tough or rigid, triangular, vaginate (pl. 4, fig. 39-42), and are dorsally ridged or keeled, brownish to blackish on their exposed portions and greenish inside. The sheaths of the bud scales become correspondingly broader on their basal portions, whence they remain practically uniform inward. The laminar primordia are much longer on the outer (pl. 4, fig. 39-41) exposed bud scales, becoming shorter on the inner scales, until this organ is evident only as a small conical protrusion at their apices (pl. 4, fig. 44-49). The shape of the sheath is ovate-triangular on the outer scales (pl. 4, fig. 39-41), becoming ovate (pl. 4, fig. 42-44), then obovate to elliptic (pl. 4, fig. 45-46). The succeeding bud scales also exhibit definite form changes; the sheath becomes broader at the middle portion, tapering to an acute angle at the apex and slightly tapering toward its broad base (pl. 4, fig. 44-47). Later, the laminar primordium becomes again evident and elongates to a certain extent (pl. 4, fig. 50-52). In the floral shoot bud very often the formation of lamina on the inner scale is suppressed (pl. 4, fig. 37-38). All these inner bud scales proved to be the bracts subtending the lateral branches of the terminal floral, paniculate cluster, and they usually fall off long before anthesis.

Sometimes, the floral shoot bud fails to develop a large terminal floral cluster; instead, the axillary buds subtended by the inner scales develop into small floral clusters. In this case the upper bud scales show identical development of transition scales and leaves (pl. 4, fig. 36) such as those found in foliar shoot bud.

One distinguishing feature observed by the writers on both floral shoot (pl. 4, fig. 37-38) buds and the common mixed shoot buds (pl. 4, fig. 36) (buds developing both leaves and floral clusters) is the formation of a flat cone by their developing bud scales and their leaf primordia in contradistinction to those developed from the foliar shoot buds (pl. 4, fig. 19). This feature, which has been found to be fairly constant, is not a very safe guide in foretelling whether leaves or floral clusters would develop from a shoot bud in their earlier stage of growth. It may, however, be regarded as an incidental character connected with floral bud development from shoot buds rather than a character truly correlated with the formation of flowers.

In one instance, where the common shoot bud was studied, the change from truly bud scales to the transition form of bud scales was encountered on the thirteenth scale. In this particular scale there was shown a diminution in width of its sheath and an increased prominence of the laminar primordium. This feature becomes more conspicuous acropetally until the true leaf primordia are reached, where the sheath may totally disappear, and distinct petioles be formed instead (pl. 4, fig. 19).

It is very obvious that where small, axillary floral clusters are developed from a shoot bud, one is apt to be misled in deciding whether foliar primordia instead of flowers would be formed by it during its early development. One has, therefore, to take into account the habit of growth of the terminal leaf primordia as they more or less show a tendency to grow away from the axis (pl. 4, fig. 36), rather than vertical or parallel to it, as is usually the case with foliar shoot buds (pl. 4, fig. 19).

Microscopical

Indian No. 1.—Plate 1, figure 1 shows a typical shoot bud of this variety before smudging was begun. Both upper axillary and terminal meristems are clearly observable as humps of small, isodiametric cells containing dense cytoplasm and distinct nuclei. Signs of activity were not evident when the smudging operation was started. During the first four days of smudging, not much change in either external or internal appearance of the shoot bud was evident (pl. 1, fig. 2). On the eighth day of smudging (pl. 1, fig 3), however, the signs of growth were noticeable. The axillary meristems had enlarged considerably, while the terminal or apical one had cut off a few lateral primary bracts of the juvenile floral cluster. On the thirteenth day of smudging (pl. 1, fig. 4) these axillary meristems had started to cut off the lateral appendages which become the forerunners of the secondary bracts to the floral cluster (Juliano and Cuevas, 1932), the original inner bud scales then functioning as the primary bracts. The axillary meristems borne lower than the young lateral branch of the inflorescence shown in the figure are very advanced in growth.

When the shoot buds have attained a length of about two centimeters at the close of the fifteenth day of smudging, the lateral branch primordia to the inflorescence have already elongated, cutting off secondary bracts in acropetal succession (pl. 1, fig. 5). The inner bud scales to the shoot bud then are pushed aside and no longer cover the terminal growing point of the young infloresence. On the other hand, the terminal growing point has given rise to several primary bracts to the floral cluster, at the axils of which, new branch primordia will arise later. By the seventeenth day, greater differentiation has been attained; the lateral branch primordia of the juvenile inflorescence have given rise to lateral secondary bracts at the axils of which floral primordia are developed (pl. 1, fig. 6).

Indian No. 2.—The shoot bud of this tree prior to smudging (pl. 3, fig. 12) is very similar to that of the Indian No. 1 (pl. 1, fig. 1). The embryonic humps of meristematic cells at the axils of the upper scales are easily distinguished, but no sign of activity could be noted. During the time of smudging, activity was not exhibited by the axillary meristems, the scales simply spread out because of the elongation and activity of the terminal growing point. This apical meristem at the end of the fifteenth day of smudging actively cut off lateral leaf primordia (pl. 3, fig. 14) in acropetal succession, instead of floral or reproductive organs as were found in buds of Indian No. 1. Even as early as the eighth day after smudging (pl. 3, fig. 13), the shoot bud remained inactive and irresponsive to the stimulus of smudging. Microscopically, it appeared similar to buds at the time smudging was started (pl. 3, fig. 12). In fact, at the end of smudging, this particular tree had not produced any flowers at all; instead foliage leaves were formed. It is very apparent from what had been and was observed in this particular tree that if the shoot bud will not form reproductive organs, the potentially axillary meristematic tissues subtended by the scales to the shoot bud never become activated, but remain wholly rudimentary in character. Growth takes place only in the apical meristem. It may, therefore, be possible to tell, microscopically, whether a shoot bud will form reproductive organs or not, because if leaves instead of flowers will arise from it, only its terminal apical meristem will exhibit growth (pl. 3, fig. 13-15). Another interesting point that the writers noticed during the smudging of these two Indian mango trees was that the shoot bud which developed leaves actually showed much more active elongation at any given time than those buds which developed inflorescence.

Pico.—The shoot bud prior to smudging was dormant (pl. 2, fig. 8) as evidenced by the faint development of its apical meristem and lack of proper organization of the lateral axillary meristems subtended by the scales to the shoot bud. In the first seven days of smudging the shoot buds did not show any apparent reaction to the operation; growth took place only on or just after the eighth or ninth day of smudging (pl. 2, fig. 9). By the thirteenth day, growth had actually proceeded (pl. 2, fig. 10). The shoot bud had the tips of its outer scales distended and open. The terminal meristem had cut off laterally its primary bracts, while the lateral or axillary branch initials had elongated considerably, cutting off simultaneously their lateral secondary bracts. By the fifteenth day (pl. 2, fig. 11) growth was much more advanced, the whole floral cluster had attained a length of about five centimeters. At this stage the floral primordia were clearly formed at the axils of the secondary bracts developed from the lateral branches of the floral cluster.

Macroscopically, the writers observed that as the inflorescence developed from the smudged shoot bud, the outer scales usually dried up and fell off, owing perhaps to the pressure of the enlarging and elongating inflorescence initial within. Before the emergence of the juvenile floral cluster, its numerous primary bracts protruded at nearly the scale level.

Carabao.—Prior to smudging, the shoot buds of this tree were dormant (pl. 3, fig. 15). Sections from shoot buds by the ninth and fifteenth days of smudging, (pl. 3, fig. 16-17) did not reveal any sign of growth. The scales remained imbricate and tightly covered the growing point. It should be remarked at this juncture that the shoot buds which were actually smudged by the writers did not produce new growth even after fifteen days of smudging, but those on the side opposite the portion actually smudged exhibited new flush. As stated earlier in this paper, this tree had never fruited.

DISCUSSION

The study of bud differentiation in smudged mango trees is of much importance, especially when the amount of time and money involved in this operation is taken into account. In the early part of the smudging period diagnostic characters of smudged shoot buds tending to indicate what structures will arise from them would certainly be of practical value. During the time the mango trees used in this investigation were being smudged the writers observed that certain peculiar behaviors of the shoot buds may be taken as an index by which it can be detected whether flowers or leaves would arise from them. Knowing this, the smudging operation can be stopped or continued and thus prevent waste of time and money.

Macroscopical examinations reveal two interesting facts about shoot bud behavior of mango trees during smudging. First, if the shoot bud will form foliar leaves alone, its scales exhibit distinct changes in shape of the sheaths as follows: triangular deltoid to ovate deltoid, broadly obovate then oblong, the laminar primordia decreasing in length until the transition scales are reached. The sheaths simultaneously elongate considerably, and become narrow; their laminar primordia shorten and then elongate, developing on their adaxial sides slight, winged outgrowths as beginnings of laminar primordia. The successive structures correspondingly bear increasingly developed laminae which prove to be distinct young foliar leaves. In addition, the foliar shoot bud usually exhibits marked rapid elongation, the tips of its juvenile scales and leaf primordia forming more or less a sharp, acute cone (pl. 4, fig. 19).

Second, if the shoot bud will form a floral cluster, the inner bud scales which are mostly derived from the apical meristem show definite character. The outer bud scales, however, are no different from those found in shoot buds which form either leaves alone, or floral clusters and leaves together (mixed buds). The inner bud scales of the floral shoot bud never show distinct laminar formation but prove to be primary bracts subtending the lateral branches to the floral cluster. In some cases, a shoot bud may exhibit the development of leaves, but at the same time floral clusters are formed in the axils of the bud scales. This last kind of shoot bud (mixed bud) can, however, be fairly well distinguished from the regular foliage shoot bud by the peculiar arrangement of the tips of their leaf primordia. The apices of the leaf primordia are at almost the same level and directed away from the axis of the shoot bud; whereas, in the foliage shoot bud, they are uneven and held vertically. This criterion may hold in a majority of cases, but not in all as the reverse condition may often be encountered.

Microscopical study of shoot buds which formed either floral clusters or simply leaves revealed that they were dormant before smudging was begun. The embryonic cells constituting the terminal as well as the axillary lateral meristems subtended by the bud scales were essentially alike in shape and appearance, hence, the difficulty of foretelling, prior to smudging, what structure or structures would be formed from them seems very evident. However, after from six to eight days, it can, to some degree, be told whether a shoot bud would form leaves or inflorescence or both. If inflorescence will develop, growth can be detected in both the lateral embryonic cells subtended by the bud scales, and in those of the apical meristem; if leaves will arise, only the apical meristem takes an active part. In cases where both leaves and floral clusters are formed simultaneously from a single shoot bud, the apical meristem forms the leaves, while the lateral axillary embryonic cells subtended by the scales form small, individual floral clusters. These mixed buds can be differentiated from shoot buds developing leaves alone by the peculiar growth of the apices of the terminal juvenile leaves, as was described. At all events, as observed by the writers, the apical meristem is the one forming the largest floral clusters.

After the fruiting season, the first flush of the shoot buds will develop from the dormant axillary buds subtended by the uppermost leaves of the last flush.

It is not improbable that leaves instead of flowers would develop if the smudging were discontinued after a few days, that is, before the stimulated initials have reached the stage of complete differentiation. It is hardly probable, however, that reproductive initials will revert to vegetative ones, no matter how short the smudging operation is once differentiation has set in. In this connection, it would be interesting to determine whether the smudged shoot buds which have attained complete differentiation in six to eight days after smudging would continue to develop to maturity if the stimulus were then removed, a line of investigation that the writers hope to undertake in the future.

Gonzalez (1923) in his smudging experiments with mango trees during 1921-1922 was able to induce the growth of shoot buds to a length of two centimeters in a period of 22-23 days in August, 20-35 days in September, 9-13 days in October, 13 days in November, 12-14 days in December, 1921, and 13-14 days in January, 1922, giving an average of 16.75 days. In another set of experiments, monthly smudging from June, 1921 to January, 1922, involving 40 smudging operations, it took an average of 16.225 days to force the shoot buds to grow to the length of two centimeters. In the present investigation the writers noted that in the Indian No. 1 and Pico trees the shoot buds had attained the length of two centimeters at the end of 15 days of smudging.

The quicker response of mango trees to smudging reported by some farmers who claim that they have observed flowering after five days of smudging, was not experienced in this work. If this had been the case, however, or if smudging were done when the shoot buds were not dormant and undifferentiated, the differentiation of reproductive structures, as well as vegetative leaves, would have been accomplished shortly after smudging was started. The longer time observed by the writers for the emergence of young inflorescence, as well as leaves, in the mango trees under study can not be attributed to the low temperature for the writers took special care to produce as much smoke as possible, with its concomitant heat, but without burning. In fact, the Indian No. 1 and the Pico tree had at least four smudges under them, and during the operation some of the lower leaves showed burning because of too high temperature. It is very probable that the trees mentioned above as exhibiting very quick response to smudging had their shoot buds well started in development, so that the smudge only served as a "catalyzer" or an accelerator to their rapid growth, but not to their differentiation.

SUMMARY

Description of dormant shoot bud as well as salient macroscopical characters of those smudged shoot buds which develop leaves alone, floral clusters alone, and floral clusters and leaves are given.

Foliar shoot buds possess ovate deltoid to broadly obovate inner scales, becoming oblong inward. The laminar primordia of these inner bud scales correspondingly decrease in length, becoming shorter and shorter until the transition bud scales are reached. The bases of their sheaths become narrower in the most interior bud scales, while their lengths increase so that the last of the inner bud scales usually possess somewhat elongated, elliptical sheaths. The transition form of bud scales which may be one of several, show decidedly narrow sheaths which undergo a marked decrease in width, and extreme elongation. Simultaneously, their laminar primordia become considerably lengthened, and on their adaxial sides they bear slight, winged outgrowths as the first sign of laminar formation. Subsequent transition bud scales may show progressive development of laminae until true leaf primordia are reached. These foliar shoot buds usually present a very marked elongation, their tips never forming a flat cone.

Floral shoot buds show nearly identical forms and sizes of their inner bud scales, and very often the formation of laminae on their inner scales is suppressed. These inner scales become bracts subtending the lateral branches of the terminal floral paniculate cluster. In mixed buds the upper scales show identical development of transition scales and young leaves as those in foliar shoot buds. The floral shoot buds as well as the mixed buds generally form a flat cone with their developing bud scales and leaf primordia, although this feature may not hold true in all cases. This character is regarded as an incidental one connected with floral bud development from shoot buds rather than one truly correlated with the formation of flowers.

Microscopically, these types of shoot buds can be distinguished as early as from the sixth to the eighth day of smudging; the one which will form flowers exhibits activity in its apical, as well as in lateral or axillary meristems, while the one which will develop only leaves shows growth confined largely to its apical meristem developing foliage leaves.

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EXPLANATION OF PLATES

Plate 1. Indian No. 1

Fig. 1. Longitudinal section of a dormant shoot bud before tree was smudged. × 40.
Fig. 2. Shoot bud on the fourth day of smudging. × 40.
Fig. 3. Shoot bud on the eighth day of smudging. × 40.
Fig. 4. Shoot bud on the thirteenth day of smudging. × 40.
Fig. 5. Portion of a shoot bud on the fifteenth day of smudging, showing upper branch primordia of the floral cluster at the axils of the primary bracts. × 40.
Fig. 6. Portion of an older inflorescence showing one of its upper lateral branches forming floral initials at the axils of the secondary bracts. × 40.

Plate 2. Indian No. 1 and Pico

Fig. 7. Enlarged view of the growing point of the shoot bud of Indian No. 1 showing numerous trichomes borne on the upper or ventral surface of the bud scales. × 80.
Fig. 8. Shoot bud from Pico mango before smudging. × 40.
Fig. 9. Shoot bud on the ninth day of smudging. × 40.
Fig. 10. Shoot bud on the thirteenth day of smudging; note the apical meristem cutting off primary bracts while the lateral meristems (branches to the inflorescence) have started to cut off their secondary bracts. × 40.
Fig. 11. Portion of a much older shoot bud showing its terminal growing point, and lateral branches much more advanced in development. × 40.

Plate 3. Indian No. 2 and Carabao

Fig. 12. Shoot bud from Indian No. 2 before smudging. × 40.
Fig. 13. Shoot bud on the eighth day of smudging. × 40.
Fig. 14. Shoot bud on the fifteenth day of smudging; note the absence of activity of lateral, axillary meristematic cells. × 40.
Fig. 15. Shoot bud from Carabao tree before smudging. × 40.
Fig. 16. Shoot bud on the ninth day of smudging. × 40.
Fig. 17. Shoot bud on the fifteenth day of smudging. × 40.

Plate 4. Indian No. 1

Fig. 18. Diagram of transverse section of a shoot bud showing relative positions of the outer (darkened) and inner (unshaded) scales; dotted structure represents the main axis. × 7.
Fig. 19. Lateral view of a smudged foliar shoot bud. × 1½.
Figs. 20-34. Individual scales (dorsal view) subtending the smudged foliar shoot bud shown in figure 19. × 2.
Fig. 35. Transition scale from the smudged foliar shoot bud shown in figure 19. × 2.
Fig. 36. Lateral view of smudged mixed shoot bud with its outer scales removed to show the basal axillary primordia of the young inflorescence and the terminal cluster of leaf primordia exhibiting distinct laminae. × 1½.

Fig. 37. Lateral view of a typical floral smudged shoot bud with the outermost scales shed. × 1½.

Fig. 38. Another typical floral smudged shoot bud. × 1½.

Figs. 39-52. Dorsal view of the scales from floral shoot bud shown in figure 38. Note the absence of distinct development of laminae in any of them. × 2.

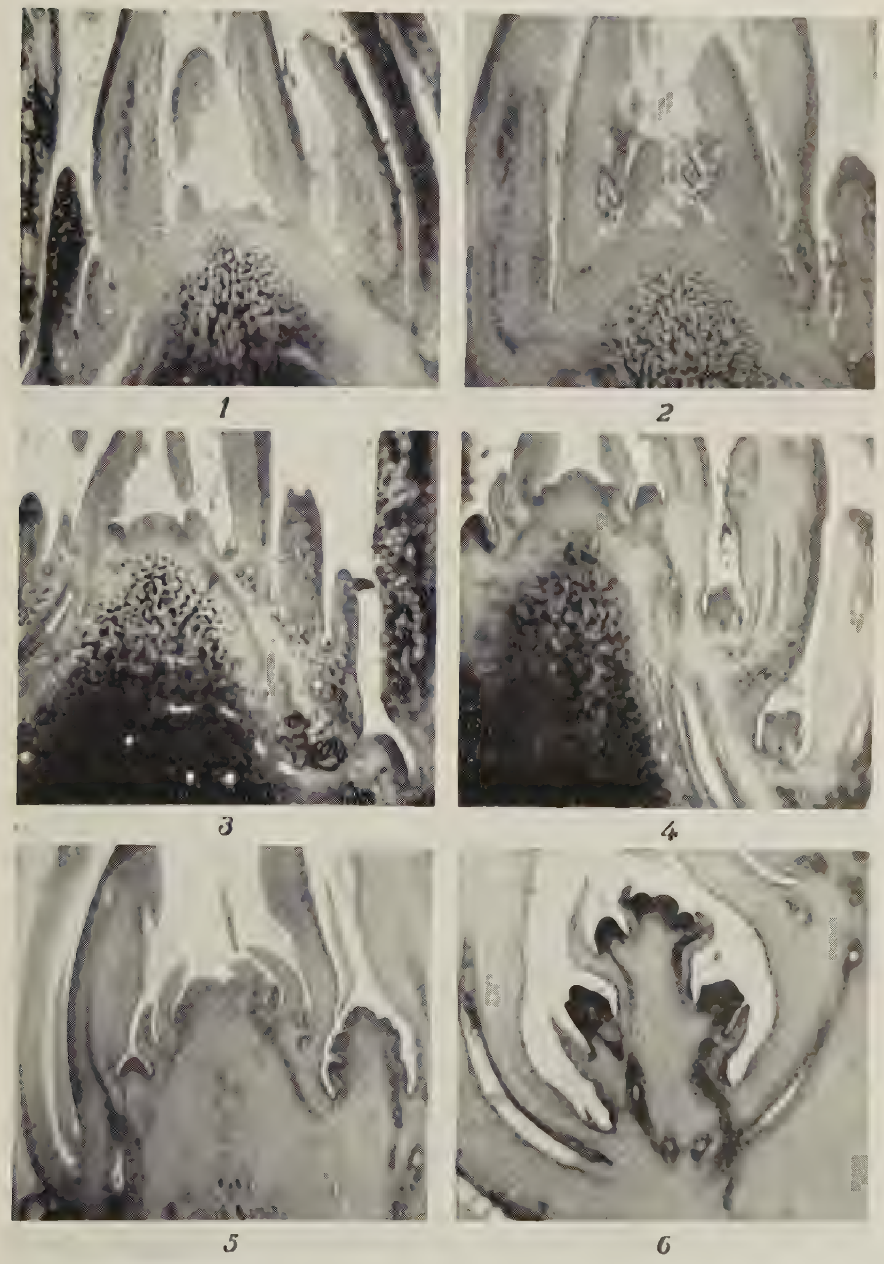
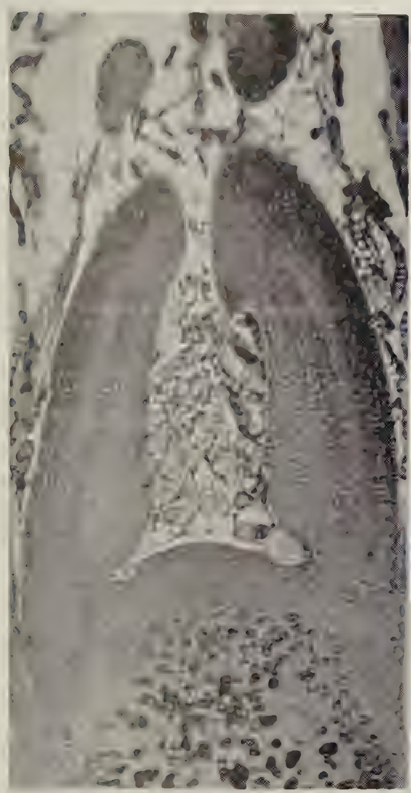


PLATE I



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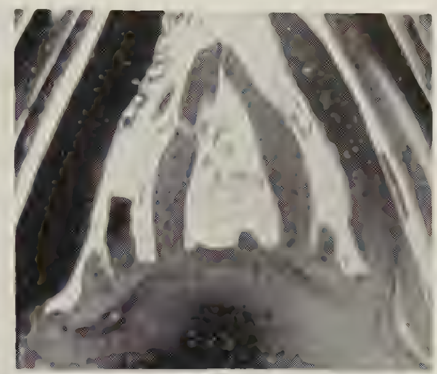

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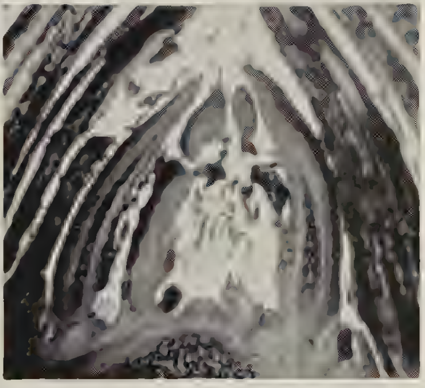

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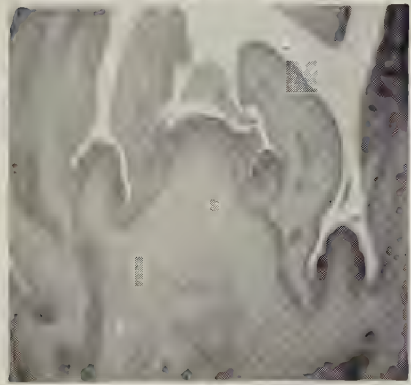

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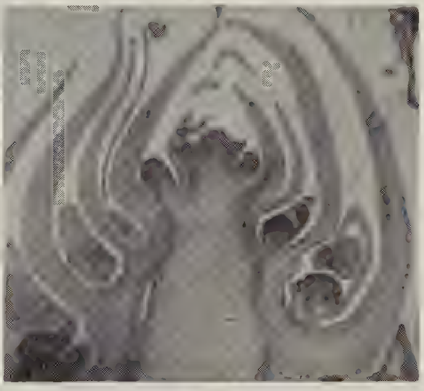

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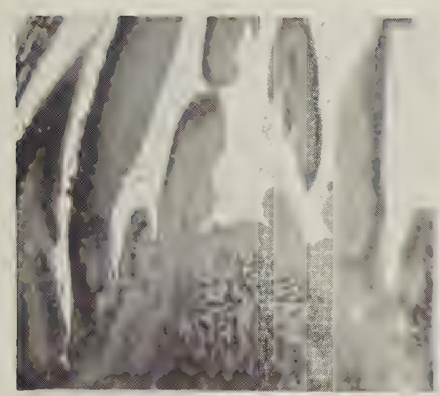
PLATE II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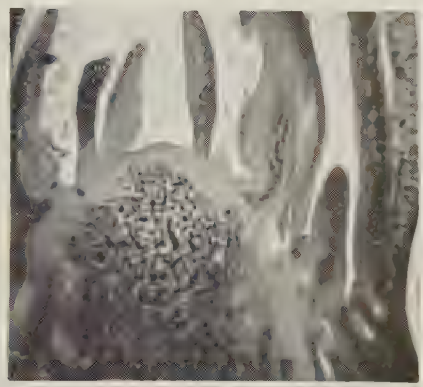
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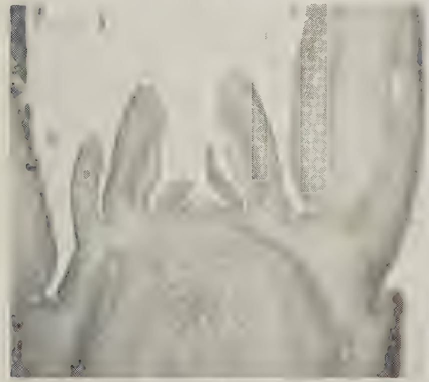
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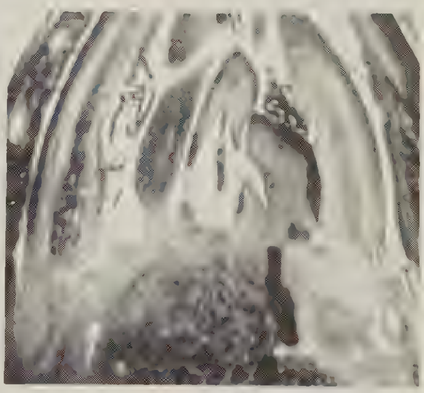
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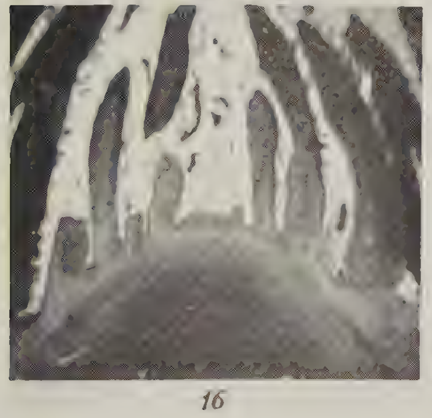
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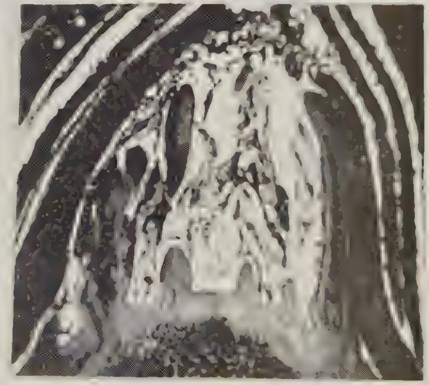
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PLATE III

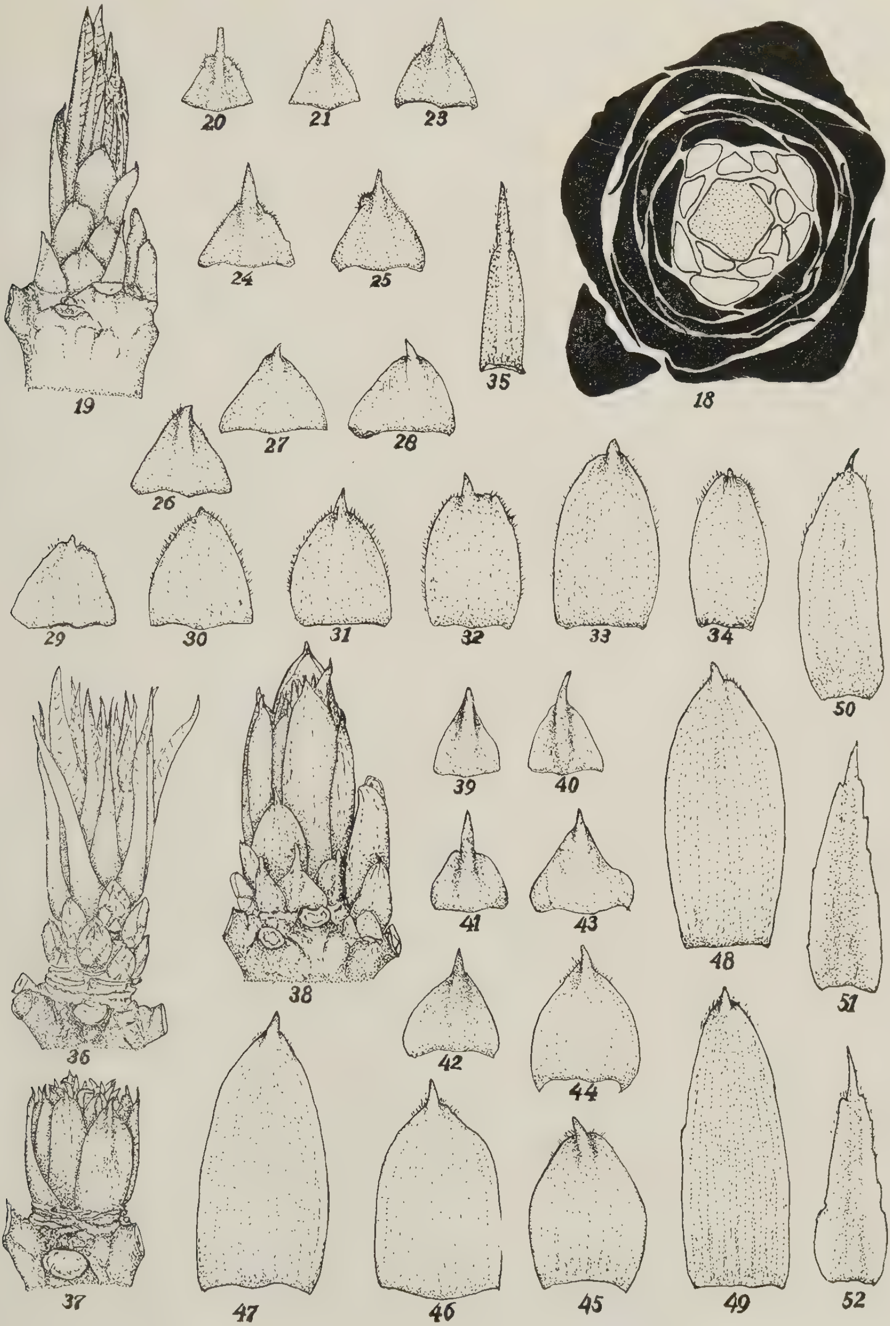

PLATE IV

STUDIES ON THE PHYSICAL QUALITIES OF THE HEN'S EGG: II. INFLUENCE OF SEASONAL CHANGES ON THE PHYSICAL QUALITIES OF NEW-LAID LOS BAÑOS CANTONESE EGGS[1]

F. M. FRONDA, D. D. CLEMENTE, AND ENGRACIO BASIO

The most important characteristics of new-laid Los Baños Cantonese eggs was described by Fronda and Clemente (1934). They reported that a new-laid Los Baños Cantonese egg has a specific gravity of 1.056 ± 0.0098. They also observed that when such an egg is placed in a vessel of clear pipe water, the egg lies almost flat on its side with the butt tilted up with an angle of inclination of 10.84 ± 0.1810 degrees, and that the air cell of a new-laid Los Baños Cantonese egg has a height of 0.140 ± 0.0012 centimeter, a diameter of 1.323 ± 0.0081 centimeters, and an air cell index of 0.108 ±0.0006. The yolk is 1.864 ± 0.0117 centimeters high and has a diameter of 3.957 ± 0.0141 centimeters. The yolk index of a new-laid Los Baños Cantonese egg is 0.472 ± 0.0027.

The next questions that poultry producers and consumers should be interested in are: (*a*) Do new-laid Los Baños Cantonese eggs produced in different months present similar characteristics? (*b*) To what extent will seasonal changes affect the internal qualities of new-laid Los Baños Cantonese eggs?

To answer these questions, the observations reported in this paper were made. The studies were conducted in the Poultry Laboratory, Department of Animal Husbandry, College of Agriculture, Los Baños, from November, 1931 to October, 1932, thus covering a period of exactly one year.

PLAN OF THE STUDY

Twelve sets of observations were made, one set for each month. The dates on which the observations were made were as follows:

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[1] Part of the expenses incurred in this study were paid from a research grant by the Philippine Poultry Association. The figures presented in this paper were recomputed from data contained in the thesis presented by D. D. Clemente for graduation March, 1933, with the degree of Bachelor of Science in Agriculture No. 448; Experiment Station contribution No. 1027. Received for publication September 12, 1934.

SET NO.	DATE
1	November 14, 1931
2	December 11, 1931
3	January 10, 1932
4	February 15, 1932
5	March 15, 1932
6	April 12, 1932
7	May 12, 1932
8	June 8, 1932
9	July 14, 1932
10	August 7, 1932
11	September 9, 1932
12	October 6, 1932

The following characters were studied: (*a*) specific gravity; (*b*) height and diameter of the air cell and the air cell index; (*c*) height and diameter of the yolk and yolk index; (*d*) size of the germ; and (*e*) angle of inclination of the egg when submerged in clear pipe water. The methods used in studying these characters were similar to those described by Fronda and Clemente (1934).

The data on specific gravity and dimensions of the air cell were obtained from 185 new-laid Los Baños Cantonese eggs. The data on the dimensions of the yolk, size of germ, and angle of inclination of the egg when submerged in water was obtained from 10 eggs that had been picked at random from these 185 eggs. Observations were made within 24 hours after the eggs were laid.

RESULTS AND DISCUSSIONS

Specific gravity. Table 1 gives the means of the weight, volume, and specific gravity of the eggs studied during the different months of the year. By reference to this table, it may be seen that the weight of the eggs varied from month to month, the minimum being in November. From this month the weight increased till January when the heaviest weight was recorded. In February, the weight slightly decreased and this weight was maintained with slight variations during the rest of the year. The variations in the volume of the eggs more or less followed the same tendency as the weight.

These results may be expected as the birds that produced the November eggs were the younger, hence laid lighter eggs (Jull, 1930). Not only were the eggs that were laid from January produced by older birds, there was a high production of eggs so that in sampling there was a better chance for selection, hence, the tendency was to eliminate the smaller eggs. Funk and Kempster (1934) stated also that actually more food materials are in eggs laid during the breeding season than in those laid during the other months of the year. It follows that these breeding season eggs will tend to be heavier than the others.

As may be seen in table 1, the specific gravity of the eggs laid during the different months varied from 1.031 ± 0.0010 in March to 1.072 ± 0.0010 in January. The differences between the specific gravity of the eggs laid from November to April are marked, but after April, the differences are only slight. But, curiously enough, the specific gravity of eggs laid during the first month of the normal laying season, January, (Fronda, 1928) was the highest of the year; then the specific gravity decreased as the season progressed till the minimum was reached in March when it again began to increase. After May, when egg production normally begins to gradually decrease, the specific gravity of the eggs remained the same.

These results seem to show that there is a tendency for eggs laid during the breeding season to have a lower specific gravity than those produced during the other seasons of the year. The increased weight of the eggs may be due to increased food materials which Nature provides during the breeding season for the embryo chicks, as suggested by Funk and Kempster (1934), rather than in the increase in the amount of shell materials in the egg. Mussehl and Halbersleben (1923) however, claim that variations in the thickness of the shell are more likely to influence the specific gravity of eggs than are variations in protein or fat content. Further studies along this line will be necessary before a definite conclusion can be made.

Air cell. Table 2 gives the variations in the dimensions of the air cells and in the air cell indices of eggs laid during the different months of the year. By reference to this table, it can be seen that the height of the air cell varied from a minimum of 0.125 ± 0.0011 cm. in April to a maximum of 0.162 ± 0.0017 cm. in January. It is surprising to note that the height of the air cells of eggs laid from February to June, the hottest and driest months, was much less than that of eggs laid during the other months.

When the heights of the air cells of the eggs laid from February to June were averaged, the mean was 0.132 ± 0.0018 cm. The mean height of the air cells of eggs laid from July to January was found to be 0.148 ± 0.0023 cm. The difference between these two means is 0.016 ± 0.0027 cm., a significant difference. Thus, it may be concluded that eggs laid during the dry, hot months have thinner initial air cells than those laid during the wet months. It is possible that the hen protects the rapid loss of moisture from the egg during the dry and hot months by providing some special protective substances in the egg shell, or by a better construction of the shell itself.

The diameter of the air cells of eggs laid during the different months of the year did not vary as much as the height. It may be seen by reference to table 2, that the shortest diameter of the air cell was recorded from the April eggs, 1.267 ± 0.0067 cm. The air cells of the eggs laid in January had the longest diameter, 1.382 ± 0.0067 cm. No definite tendency is noticeable in the variation of the mean diameters of the air cells of eggs laid during the different months of the year. Apparently, the initial diameter of the air cell is not as much influenced by the season as is the height.

Perhaps, the volume of the air cell may give a better expression with respect to the size of the air cell than either the height or the diameter alone, although, in actual practice, it is the height alone that is more frequently used in grading eggs commercially. To get the exact volume of the air cell, however, is not practical. In this paper the air cell has been considered as a perfect cone, so that its approximate volume can be easily determined by using the following formula:

$$V = \tfrac{1}{3} h \pi r^2$$

In this formula, r is the radius and h is the height of the air cell.

Applying this formula and using the figures in table 2, it was found that the volume of the air cell varied from a minimum of 0.0530 cc. in May to a maximum of 0.0810 cc. in January. The mean volume of the air cells of eggs laid from February to June was observed to be 0.0584 ± 0.0014 cc., while that of eggs produced from July to January was 0.0677 ± 0.0019 cc. The difference between these two means is 0.0093 ± 0.0024 cc., a very significant difference. This difference shows conclusively that the air cell of eggs laid during the dry, hot months is really smaller than that of eggs laid during the wet months.

Again, by reference to table 2, it may be noted that the air cell index of the eggs laid during the different months of the year followed the same trend as the height of the air cells, and this varied from 0.102 in April to 0.123 in November. The differences in the air cell indices of the eggs laid during the different months, with the exception of those from August to October, although small, were significant. When the months were again considered in two groups, February to June, and July to January, and the means of the air cell indices were determined, it was observed that the mean for February to June was 0.106 ± 0.0009 and that for July to January 0.113 ± 0.0015, with a small, but significant difference of 0.007 ± 0.0017.

Yolk. Table 3 gives the dimensions of the yolks and the yolk indices of eggs laid during the different months of the year. By reference to this table it is apparent that variations in the height of the yolk from one month to another are not very marked, although there is an apparent tendency for the yolks of eggs laid during the dry season to be flatter than of those laid during the rest of the year. The minimum height of the yolk was recorded in April as 1.755 ± 0.0137 cm. and the maximum in November, 1.892 ± 0.0127 cm. The mean height of the yolks of eggs laid from February to June was observed to be 1.813 ± 0.0109 cm., while that of from July to January eggs was 1.841 ± 0.0098 cm. The difference, however, between the two means was only 0.028 ± 0.0146 cm. which is not significant.

The means of the diameter of the yolks of eggs laid during the different months of the year are given in table 3. By reference to this table, it may be noted that the variations of these means do not follow any definite trend. The minimum diameter of the yolk was observed in eggs laid in October to be 3.850 ± 0.0204 cm.; the maximum, only 4.035 ± 0.0395 cm., was in November. The diameters of the yolks of eggs laid during the hot, dry months of the year lie somewhere between these two means. Apparently, the initial diameter of the yolk of eggs is not influenced by conditions of the weather.

According to Sharp and Powell (1930) the yolk index is a better guide in determining the quality of eggs than any other factor. They observed that the yolk index decreased faster at higher temperatures than at lower. By reference to table 3, however, it may be noted that, in general, the initial yolk index of eggs laid during the hot months was not significantly lower than that of eggs laid during the cooler months. The minimum yolk index was observed in the eggs laid in January, to be 0.452 ± 0.0065 and the maximum in eggs laid in October, 0.488 ± 0.0065.

Size of germ. In studying the diameter of germ, only eggs that have been fertilized were included. The fertile eggs were differentiated from the infertile ones by using as closely as possible Benjamin's (1930) description as a guide.

The means of the diameter of the germs of eggs laid during the different months of the year are given in table 4. By reference to this table it may be seen that there is a tendency for the size of the germs of eggs laid during the different hot months of the year to be larger than those laid during the wet months. The diameter varied from a minimum of 0.602 ± 0.0209 cm. in October to a maximum of 0.696 ± 0.0168 cm. in May.

The fact that the maximum diameter was observed in eggs laid in May led us to the conclusion that temperature may have an influence in determining the size of the germ of new-laid eggs. When the mean of the diameters of the germs of eggs laid from February to June, corresponding to the dry season was determined, it was found that this was 0.649 ± 0.0083 cm. The mean diameter of the germs of eggs laid during the wet season was 0.628 ± 0.0071 cm. The difference between these two means is 0.021 ± 0.0109 cm. which, although not very significant, shows that there may be some tendency for new-laid eggs produced during the dry season to have larger germs than those laid during the wet season.

Angle of inclination. The means of the angle of inclination of eggs laid during the different months of the year, when submerged in clear pipe water are also given in table 4. By reference to this table, it may be seen that while the differences in the means from month to month may not be large enough to be significant, there is a general tendency that the angle of inclination of eggs laid during the dry, hot months may be seen to be smaller than that of eggs laid during the wet months. For instance, the minimum angle of inclination, 6.7 ± 0.472 degrees, was observed to be in eggs laid in March and the maximum, 10.8 ± 0.4552 degrees, to be in November eggs. The difference between these means is 4.1 ± 0.6536 degrees, a significant difference.

The mean angle of inclination of eggs laid during the hot months, February to June, was determined and found to be 8.4 ± 0.2807 degrees, and that of eggs laid from July to January, the wet months of the year, 9.7 ± 0.2293 degrees. The difference between these means is 1.3 ± 0.3624, which is significant, also.

Fronda and Clemente (1934) gave the size of the air cell and the difference in the thickness of the shell between the tip and the butt of the egg as factors that cause variations in the angle of inclination of new-laid eggs. From the data obtained in this study, it is to be expected that the angle of inclination of eggs laid during the hot, dry months will be smaller than of those laid during the wet months, for the eggs produced during the dry months have significantly smaller air cells than those laid during the wet.

SUMMARY OF CONCLUSIONS

A study of the characteristics of new-laid Los Baños Cantonese eggs produced during the different months of the year is reported in this paper. From the data obtained, the following conclusions were drawn:

1. The maximum weight of eggs was observed in January, after which the weight slightly decreased; this weight was maintained with slight variations during the rest of the year.
2. The variations in the volume of the eggs studied followed about the same tendency as the weight.
3. The results obtained in the study seem to show that there is a tendency for eggs laid during the breeding season to have a lower specific gravity than those produced during the rest of the year.
4. The initial air cells of eggs laid during the dry, hot months are thinner than those of eggs produced during the wet months.
5. Apparently, the initial diameter of the air cell is not as much influenced by the season as is the height, for no definite tendency was noticeable in the diameters of the air cells of eggs laid during the different months of the year.
6. The air cells of eggs laid during the dry, hot months are smaller than those of eggs produced during the wet months.
7. The air cell index of eggs laid during the hot months is smaller than that of eggs produced during the wet months.
8. There is an apparent tendency for eggs laid during the wet months to be more upstanding than those laid during the dry, hot months.
9. No significant difference was observed between the yolk index of eggs laid during the hot, dry months and that of the eggs laid during the wet months.
10. There is a tendency for new-laid eggs produced during the dry season to have larger germs than those laid during the wet season.
11. New-laid eggs produced during the dry season have significantly narrower angles of inclination when submerged in clear pipe water than those laid during the wet season.

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TABLE 1

Showing variations in weight, volume, and specific gravity of eggs laid during the different months of the year

MONTH	WEIGHT	VOLUME	SPECIFIC GRAVITY
	grams	*cc.*	
November	41.76 ± 0.1824	39.52 ± 0.1778	1.057 ± 0.0011
December	43.32 ± 0.1799	40.76 ± 0.1834	1.067 ± 0.0011
January	44.65 ± 0.1884	41.80 ± 0.1683	1.072 ± 0.0010
February	43.41 ± 0.1878	40.83 ± 0.1917	1.066 ± 0.0009
March	43.61 ± 0.2006	40.77 ± 0.2197	1.031 ± 0.0010
April	42.36 ± 0.1765	39.98 ± 0.1747	1.059 ± 0.0012
May	42.58 ± 0.1793	39.93 ± 0.1680	1.064 ± 0.0010
June	40.80 ± 0.2010	40.34 ± 0.1910	1.060 ± 0.0012
July	42.40 ± 0.1944	38.95 ± 0.1508	1.064 ± 0.0011
August	43.11 ± 0.2002	40.42 ± 0.1980	1.066 ± 0.0011
September ...	43.11 ± 0.2283	40.26 ± 0.2034	1.068 ± 0.0011
October	44.08 ± 0.1964	40.02 ± 0.2292	1.071 ± 0.0011

TABLE 2

Showing variations in the dimensions of the air cells, and the air cell index of eggs laid during the different months of the year

MONTH	HEIGHT OF AIR CELL	DIAMETER OF AIR CELL	AIR CELL INDEX
	cm.	*cm.*	
November	0.160 ± 0.0014	1.340 ± 0.0058	0.123 ± 0.0008
December	0.147 ± 0.0014	1.290 ± 0.0061	0.111 ± 0.0007
January	0.162 ± 0.0017	1.382 ± 0.0067	0.120 ± 0.0010
February	0.137 ± 0.0014	1.302 ± 0.0060	0.109 ± 0.0008
March	0.140 ± 0.0014	1.333 ± 0.0055	0.107 ± 0.0008
April	0.125 ± 0.0011	1.267 ± 0.0057	0.102 ± 0.0005
May	0.130 ± 0.0010	1.313 ± 0.0062	0.108 ± 0.0006
June	0.130 ± 0.0014	1.292 ± 0.0067	0.104 ± 0.0006
July	0.145 ± 0.0014	1.292 ± 0.0064	0.106 ± 0.0006
August	0.145 ± 0.0015	1.341 ± 0.0060	0.111 ± 0.0007
September	0.141 ± 0.0014	1.301 ± 0.0071	0.111 ± 0.0007
October	0.138 ± 0.0010	1.297 ± 0.0065	0.110 ± 0.0006

TABLE 3

Showing variations in the dimensions of the yolks, and the yolk index of eggs laid during the different months of the year

MONTH	HEIGHT	DIAMETER	YOLK INDEX
	cm.	*cm.*	
November	1.892 ± 0.0127	4.035 ± 0.0395	0.469 ± 0.0044
December	1.820 ± 0.0149	3.941 ± 0.0227	0.462 ± 0.0035
January	1.786 ± 0.0252	3.953 ± 0.0221	0.452 ± 0.0065
February	1.867 ± 0.0217	3.910 ± 0.0371	0.478 ± 0.0044
March	1.807 ± 0.0228	3.891 ± 0.0218	0.465 ± 0.0059
April	1.755 ± 0.0137	3.890 ± 0.0268	0.456 ± 0.0044
May	1.815 ± 0.0202	4.000 ± 0.0491	0.455 ± 0.0069
June	1.810 ± 0.0269	3.867 ± 0.0362	0.469 ± 0.0072
July	1.802 ± 0.0173	3.943 ± 0.0195	0.457 ± 0.0045
August	1.887 ± 0.0217	3.870 ± 0.0232	0.488 ± 0.0065
September	1.872 ± 0.0198	3.894 ± 0.0175	0.481 ± 0.0054
October	1.831 ± 0.0175	3.850 ± 0.0204	0.476 ± 0.0056

TABLE 4

Showing variations in the diameter of germs and in the angle of inclination of eggs laid during the different months of the year

MONTH	DIAMETER OF GERM	ANGLE OF INCLINATION
	cm.	*degrees*
November	0.630 ± 0.0062	10.8 ± 0.4552
December	0.685 ± 0.0332	9.1 ± 0.5727
January	0.635 ± 0.0209	8.6 ± 0.4406
February	0.347 ± 0.0281	9.8 ± 0.6182
March	0.637 ± 0.0090	6.7 ± 0.4721
April	0.624 ± 0.0166	8.2 ± 0.5758
May	0.696 ± 0.0168	9.3 ± 0.4502
June	0.643 ± 0.0151	8.0 ± 0.4822
July	0.607 ± 0.0103	8.7 ± 0.3490
August	0.629 ± 0.0091	10.6 ± 0.9116
September	0.610 ± 0.0093	10.2 ± 0.5007
October	0.602 ± 0.0209	9.7 ± 0.5320

COMPARATIVE STUDY OF DIFFERENT METHODS OF TRANSPLANTING SEEDLINGS OF THEOBROMA CACAO LINN.[1]

THEODORE G. SCHUCK

WITH FOUR TEXT FIGURES AND TWO CHARTS

The effects, advantages and disadvantages of different methods of transplanting cacao seedlings from the nursery to the permanent plantation are matters of great import to cacao planters. Different methods of removing cacao seedlings from the nursery and setting them out in a permanent orchard have their effects on the growth and vigor of the seedlings. The transplanted seedlings of practically the same size and age vary greatly in the rapidity of their recovery from the shock they receive in transplanting. It is a general experience that in transplanting seedlings from the nursery to the field a considerable part of the root system is destroyed, which naturally hinders the proper development of the plants. Usually, cacao seedlings are transplanted from the nursery to the field by balling them with little or no leaf and stem pruning. This method does not only result in serious retardation of growth but also in the loss of some of the transplanted seedlings. This process of transplanting is damaging to the roots but in bare root transplanting, the cheapest method, this is inevitable.

REVIEW OF LITERATURE

In view of the commercial importance of the cacao plant in the Philippines and elsewhere, it is rather surprising that, heretofore, no report has been made on a study of the different methods of transplanting seedlings of this plant from the nursery to the permanent field.

However, some papers which deal with the general transplanting operation as applied to cacao are here reviewed.

Referring to the transplanting of cacao seedlings, Lyon (1905) stated that four or five months after the seeds are planted the roots will be so well established in the soil that if the plants are lifted carefully each may be secured with a ball of earth about its roots, placed in a tray or basket, and in this way carried intact to the field.

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[1] Thesis presented for graduation 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 450; Experiment Station contribution No. 1029. Prepared in the Department of Agronomy under the direction of Dr. Pedro A. David.

According to Wright (1907) cacao seedlings will not stand much destruction of the root system. The tap roots or lateral roots invariably get damaged, even when a transplanter is used. Hence, seedlings taken from the nursery are difficult to rear.

Quoting Barrett (1913) "As soon as the seedlings attain a height of 20 to 30 centimeters and have two to four pairs of leaves they are ready for setting out in the plantation; if necessary, the plants may, of course, be retained in the bamboo pots for three or even six months longer, but the shock at transplanting is greater in proportion as the seedling is developed beyond the eight-leaf stage. Transplanting may be done at any time of the year, though, of course, there is less danger from overheating by the sun and from over-drying of the earth during the rainy season."

In transplanting cacao seedlings, van Hall (1914) stated that the plants may be transplanted from the nursery when they have attained a height of 1 to 2 feet. Every care should be taken not to injure the roots. When the nursery is on stiff soil, the seedlings must be transplanted with a good lump of earth, about one foot in diameter. The plants must be carefully dug out with a sharp spade, with the lump remaining in its original place round the roots. Shaking causes the root-system to break, it is therefore advisable, immediately the plant has been dug out, to envelop the lump with a banana leaf fastened with dry banana fibre.

Wester (1920) writing about cacao advised that the plant bed should, after transplanting, be well watered and the tender growth pruned off before the plants are removed. The plants are dug up, the tap root and all long and sprawling roots cut back to 15 to 20 centimeters of the crown. The pruning, together with the heading back of the tap root at the time of the first transplanting, will encourage the formation of a balanced root system well supplied with fine fibrous roots; such a root system holds the soil better and aids the plant in more rapidly establishing itself after the final transplanting from the nursery to its permanent position.

Before the plants are dug up from the nursery for transplanting to the field, about one-third of the growth and most of the foliage should be pruned off in order to prevent excessive evaporation before the plant has become established in its new location.

OBJECTS OF THE WORK

The objects of the present work were: (*a*) to study the effects on cacao seedlings of six different methods of transplanting; (*b*) to compare the rapidity of recovery of cacao seedlings after setting in the field by the six different methods of treatment; (*c*) to determine the most advantageous methods of transplanting cacao seedlings under ordinary field conditions.

TIME AND PLACE OF THE PRESENT WORK

The cacao seedlings used in these experiments were planted in the nursery for permanent crops on April 14, 1932 and transplanted on July 29, 1933 in the College Plateau Plantation of the Department of Agronomy and in the College land lent to the Bureau of Forestry, Philippine Islands but leased by the writer. The actual field work was closed on February 10, 1934, thus covering a period of one year and 10 months from planting in the nursery to the present writing.

MATERIALS AND METHODS

Several hundreds of cacao seedlings were planted in the nursery beds which were one-half loam and one-half ordinary garden soil on April 14, 1932 and from these, 360 seedlings of practically the same size and 15 months old were selected for transplanting to the field. All these seedlings were measured before digging them up in the nursery. The average height of the seedlings as determined is shown in table 1.

TABLE 1

Showing the mean height of seedlings when removed from the nursery to the field

METHODS	NUMBER MEASURED	MEAN HEIGHT
		cm.
A	60	86.3 ± 2.9
B	60	90.8 ± 2.3
C	60	81.8 ± 2.2
D	60	82.5 ± 2.4
E	60	92.5 ± 2.9
F	60	94.5 ± 2.5
F [a]	200	87.5 ± 1.3

[a] Additional planting on September 13, 1933.

Land and equipment

The seedlings were transplanted in a piece of apparently uniform land of the College Plateau Plantation which is typical cacao land and in a piece of similar land leased by the writer from the Bureau of Forestry. The College land is about 76 meters long and 55 meters wide; the leased area measured 64 meters long and 44 meters wide. The two plantations cover an area of 6,996 square meters.

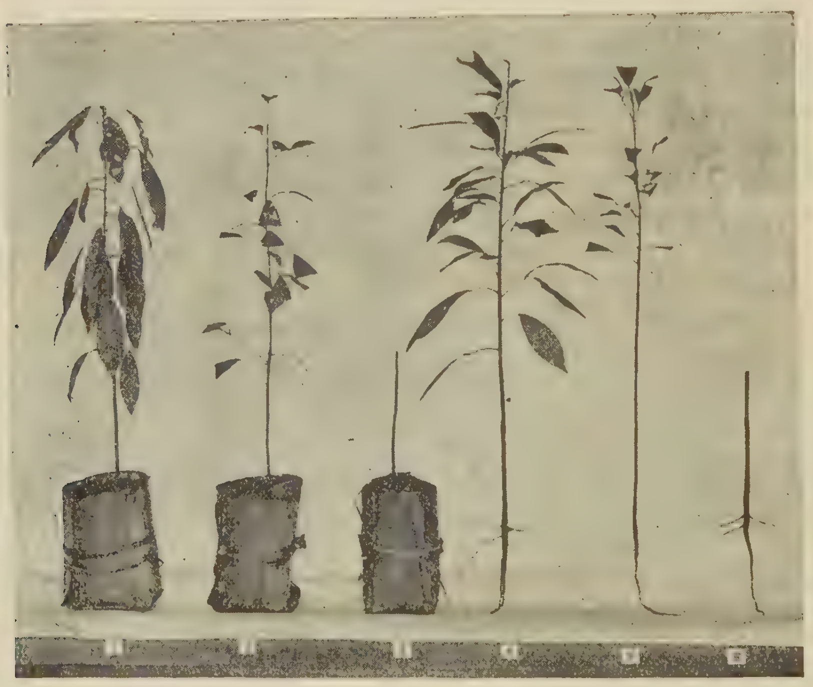

Fig. 1.—Showing different methods of transplanting cacao seedlings from the nursery to the field. From left to right, methods A, B, C, D, E, and F.

The elevations and the soil conditions of the College Plateau Plantation and the Forestry land are about the same. The only difference is the distance from the nursery where the seedlings were planted. The College Plateau Plantation is about 1.1 kilometers and the Forestry land is about .55 kilometer from the nursery.

A good spade, a mattock, a hoe and a bolo were used in digging up the seedlings from the nursery. Banana sheaths and damp sacks were used in wrapping the roots of the seedlings. It was found to be necessary to haul the seedlings from the nursery to the plantation in a bull cart. Only a garden hoe and a sickle were used in weeding around the individual plants in the field.

Treatments and methods of transplanting

Method A. Roots balled with earth and unpruned leaves. Sixty seedlings of about the same size were removed from the nursery with a ball of earth surrounding the roots of each as large as spacing in the nursery permitted, and the leaves left as nearly intact as possible. The bed was divided with a spade into squares approximately 25 centimeters across. The texture of the soil in the nursery bed allowed these blocks of soil to be lifted up without crumbling. Care was taken in digging up the plants from the beds to avoid, as much as possible, any unnecessary damage to the young roots. The ball of earth around the roots was carefully pressed to prevent crumbling and wrapped with banana sheaths ready to be carried to the field. It was found that the roots were all contained in the clod size used. A sample of the treated seedlings according to method A is shown in figure 1, plant 1. The plants without the wrapping material were set at once in the holes, which had been prepared in the field, at practically the same depth as they had been growing in the nursery. After filling in the holes, the earth was carefully pressed in around the roots. In transplanting, the seedlings were distributed in different parts of the field so as to make the conditions of the experiment as uniform as possible. These were numbered A-1 to A-60.

Method B. Roots balled with earth and one-half of the foliage cut off. An equal number of seedlings of nearly the same height were dug up from the nursery and prepared for transplanting in the same manner as in method A, except that the foliage of each seedling was reduced to one-half. This is shown in figure 1, plant 2. After the banana sheaths used for wrapping had been removed, the plants were carefully transplanted in the field at the same depth as in the original nursery bed. The plants were planted in rows adjacent to seedlings planted under method A in different parts of the field. The seedlings were numbered B-1 to B-60.

Method C. Roots balled with earth and stem cut back to a height of 30 centimeters. Sixty seedlings were removed from the nursery with their roots carefully balled in earth as in methods A and B, but the stem of each plant was cut back to a height of 30 centimeters as shown in figure 1, plant 3. The cut stem was coated with asphaltum preparation. The plants were planted in rows adjacent to those planted according to method B. They were also set at the same depth as in the nursery and the earth carefully pressed around the roots. The planted seedlings were numbered C-1 to C-60.

Method D. Roots bare of earth and unpruned leaves. Sixty seedlings of equal size were dug up from the nursery with their roots systems bare of earth and without leaf pruning. A seedling treated by this method is shown in figure 1, plant 4. Care was exercised in digging up the plants from the nursery beds to prevent root injury. The plants were carried from the nursery to the field in damp sacks. They were set in rows adjacent to those planted according to method C, and numbered D-1 to D-60, and at the same depth as in the nursery beds. After setting the plants in the hole, earth was carefully pressed around them.

Method E. Roots bare of earth and one-half of the leaves cut off. Another sixty seedlings of practically the same size were removed from the nursery beds, with their roots bare of earth as in method D, and with one-half of the leaves cut off (figure 1, plant 5). The treated seedlings were carried from the nursery to the field, each wrapped in a damp sack to prevent wilting. The roots of the plants were injured as little as possible. The plants were set in the rows adjacent to those planted according to method D. These were numbered consecutively as E-1, E-2, E-3, etc. All the plants were set in the holes at the same depth as in the nursery beds. The earth was carefully filled in around the roots.

Method F. Roots bare of earth and the stem cut back to a height of 30 centimeters. Sixty seedlings of practically the same size were dug up from the nursery beds with their roots bare of earth and the stems cut back to a height of 30 centimeters as shown in figure 1, plant 6. The cut surface of each stem was coated with asphaltum prepared for this purpose. The seedlings were carefully wrapped in damp sacks when transported from the nursery to the field. The manner of transplanting was the same as that with the previous method. The plants were set in the rows next to those planted according to method E and numbered F-1, F-2, etc.

The different methods of transplanting used will be referred to as method A, method B, method D, method E, and method F in the following discussion.

On September 13, 1933, 200 additional plants (table 1) from among those which had been left in the nursery were prepared and transplanted. The manner of transplanting was method F and each seedling planted was properly labeled.

Field observations

After clearing, lining and pegging, the land was ready for holing. The holes made in the field for the seedlings were all cubes 30 centimeters in dimension; they were partially filled in with the surface soil before setting in the plants. The seedlings were all planted 4 by 4 meters apart in quincunx arrangement. The rows were arranged in this fashion so that they were uniform as to the proportion of good and bad soil.

Out of the 60 seedlings planted under each method, only 26 were planted in the College Plateau Plantation field; the remaining 34 were planted in the field on the Bureau of Forestry land leased by the writer.

Each plant was regularly weeded for a distance of one meter around it, beginning one month after transplanting. All other field treatments were made as uniform as possible.

The young branches and leaves developed from each plant were counted weekly. At the end of seven months from transplanting the plants which were alive under each treatment were counted.

RESULTS

The mean height of the seedlings when transplanted from the nursery to the field according to the six different methods are shown in table 1.

The weekly observations and measurements on each plant in both the College Plateau Plantation and the Forestry fields, as well as those obtained in the second planting according to method F, are not included in this report but are on file in the Department of Agronomy.

The calculated percentages of plants which showed leaves and branches after a certain number of days from transplanting the seedlings are given in table 2.

The total percentage of living plants at the close of the experiment, under each method of transplanting, are shown in chart 1.

The mean number of young leaves and branches on each living plant at the close of the experiment under each method of transplanting are shown in chart 2.

Method A

In from 21 to 42 days after transplanting only 19.2 per cent of the plants planted on the College Plateau Plantation had produced new leaves and branches; 80.8 per cent had died. From the plants planted in the Forestry land a total of 17.6 per cent had produced new leaves and branches in 21 to 35 days after being set out in the field. A total death rate of 82.4 per cent was found (see table 2).

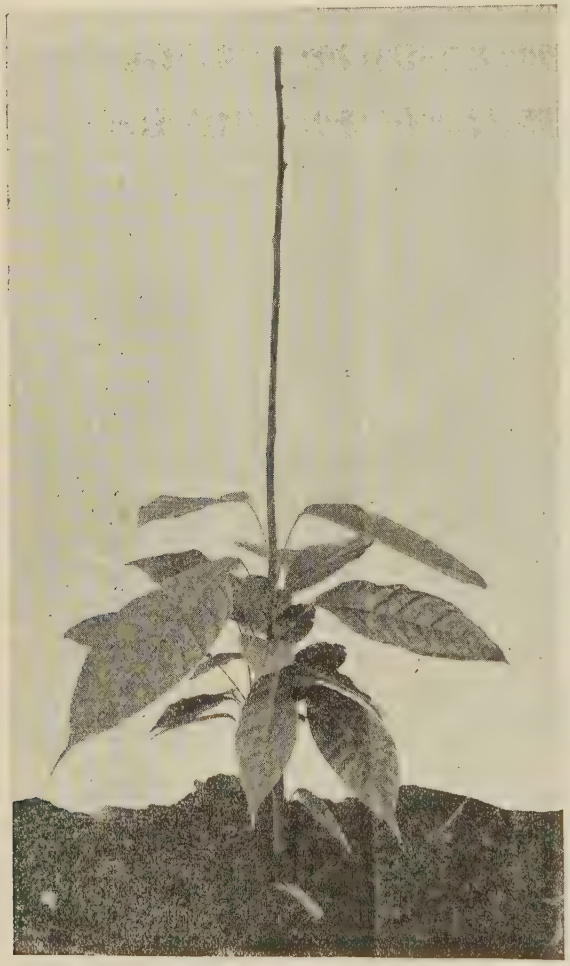

Fig. 2.—One of the living plants treated according to method A, roots balled with earth and leaves unpruned. Seven months after transplanting in the field.

At the close of the experiment no difference in vigor was noted between the plants planted in the two fields.

In from 3 to 7 days after transplanting, some of the plants treated according to this method shed their leaves. The leafless stem dried up beginning at the tip and gradually going down the stem. If the plants could not recover before the drying up reached the base of the stem the plant eventually died. A representative living plant treated by this method is shown in figure 2.

Method B

The plants planted in the College Plateau Plantation produced new leaves and branches within 21 to 70 days after being set out in the field. Only 26.9 per cent of these plants lived, 73.1 per cent died. Those plants which were planted on the Forestry land produced new leaves and branches 21 to 49 days after being set out in the field. There was a total of 23.5 per cent success and 76.5 per cent failure (table 2).

All the plants shed their leaves in the same manner as those of method A. Figure 3 shows a representative of the living plants transplanted by method B.

Method C

By this method a total of 26.9 per cent of the plants planted had produced new leaves and branches, 21 to 24 days after transplanting in the College Plateau Plantation, but 73.1 per cent failed. In from 21 to 70 days after transplanting those planted in the Forestry land showed 47.1 per cent success and 53 per cent failure (table 2). It will be noted that by this method better success was obtained than by either method A or method B.

Method D

All the plants in the College Plateau Plantation had died at the close of the experiment, and only 5.9 per cent of those planted in the Forestry land had produced leaves and branches within 84 days from the date of transplanting to the field (table 2). Plants planted by this method took a much longer time to recover than those planted by any of the methods previously described.

A few days after being set out in the field all the plants treated according to this method shed their foliage leaving only the stem standing in the field. The stems dried up beginning at the tip and drying gradually down to the base of the stem, showing the same characteristics as those described under methods A and B.

Method E

All plants planted in the College Plateau Plantation according to this method were dead at the close of the experiment. Only 14.7 per cent (table 2) of those transplanted in the Forestry land produced young leaves and branches; 85.3 per cent died. The production of the leaves and branches was noted after 63 days from transplanting. Comparing method D with method E in the Forestry land it will be found that method D was not as efficient as method E.

As with method D, the plants shed their leaves a few days after transplanting. The stem, as in methods A, B, and D, dried up beginning at the tip and drying gradually downward.

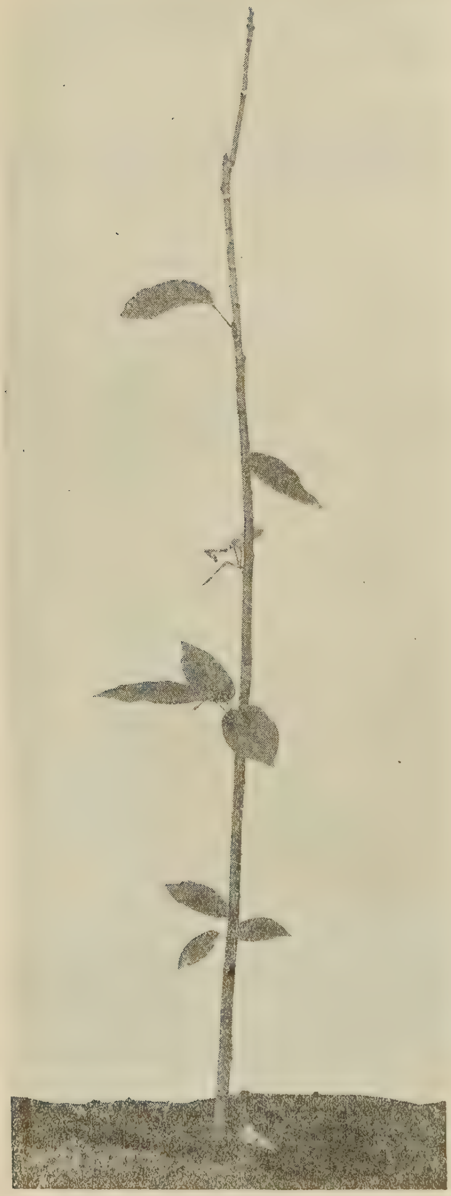

Fig. 3.—One of the living plants treated according to method B, roots balled with earth and leaves pruned to one-half. Seven months after transplanting in the field.

Method F

By this method more plants produced young leaves and branches than by any of the other methods tried. Of the plants planted in the College Plateau Plantation 30.7 per cent survived 21 to 63 days after transplanting and 69.3 per cent died. Of those planted in the Forestry land, 73.5 per cent were living 35 to 63 days after being set out in the field (table 2). A living plant transplanted by method F is shown in figure 4.

Comparing this method with methods A, B, C, D, and E it is evident that the percentage of living plants was very much higher than with any of them. Method F which was the least laborious and expensive was also the most successful. Because of the difference in labor, cost and percentage of success, this method is the most practicable.

DISCUSSION OF RESULTS

The experiment indicates that the rate of recovery varies with different methods of transplanting (table 2).

As explained in the treatments and methods of transplanting, none of the leaves of the seedlings by methods A and D were pruned. The only difference in treatment between methods A and D was that in method A the roots of the seedlings were balled with earth whereas by method D they were bare of earth. This difference in the treatment may be said to be responsible for the difference in the average number of leaves between methods A and D. While it is true that all the plants treated according to methods A and D shed their leaves a few days after transplanting, the plants treated according to method A had an advantage over the plants treated according to method D which were not balled. With method A where the roots were balled with earth, the chance of injuring or destroying them was less, consequently the plants were in better condition to fulfill their function of drawing water and food materials from the soil. With this advantage, the roots of the seedlings by method A could absorb water from the soil as it was not removed, while the roots of the seedlings transplanted by method D would need some time before they could function normally. Under these conditions the drying effect of the leaves of the seedlings at transplanting would be harder on the seedlings under method D, as is shown by the high mortality by this method.

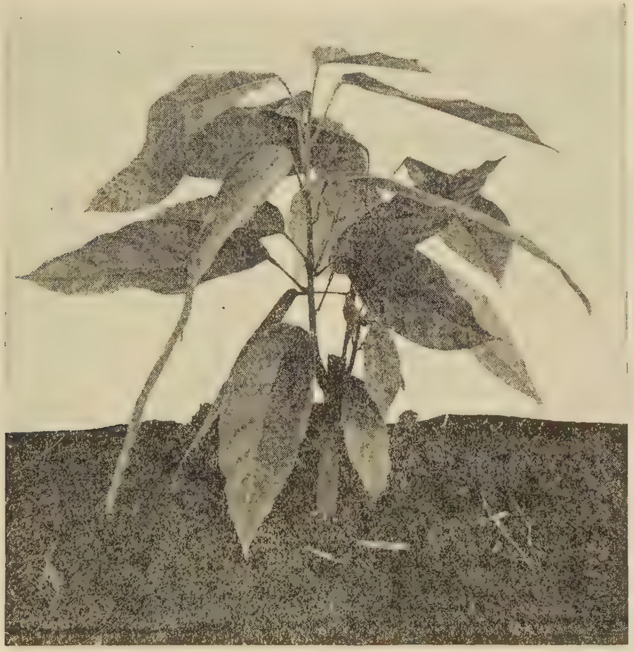

Fig. 4.—A plant treated according to method F, roots bare of earth and stem cut back to a height of 30 centimeters, 7 months after transplanting in the field.

Excessive evaporation caused the leaves on the seedlings at transplanting to dry up and consequently drop off, as with methods

A, B, D and E. The reason for the dropping off of the leaves of the plants treated by these methods may be the excessive evaporation from them. For if water is lost in transpiration (Brown, 1925) faster than it is supplied from the roots, the leaves wilt. If the excess of the loss over the supply continues, the plant finally dies. This law would seem to explain why most of the plants died under methods D and E where the regeneration of the roots was more or less inhibited or slow.

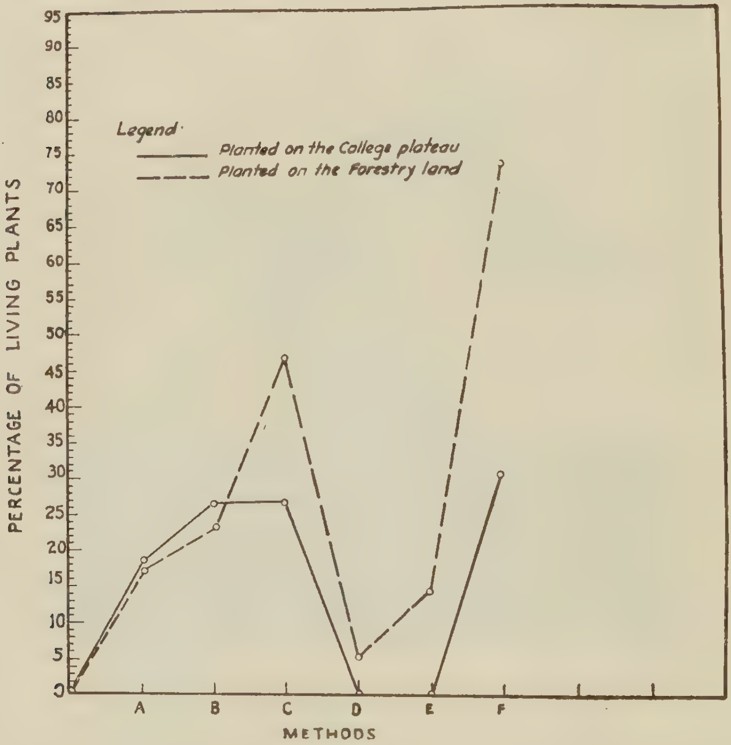

Chart 1.—Showing the total percentage of living plants under each method of transplanting at the close of the experiment.

The reason for the high average number of branches with method A is the same as that given for the high average number of leaves, inasmuch as these (leaves and branches) arise from a single primordium (see chart 2).

In chart 2 which shows the average number of branches by each method, two distinct points are shown. First, where the seedlings were balled as in methods A, B, and C the rise of the line is toward the method where the seedlings had the greatest aërial surface (initial leaf surface). In order of their average number of branches, method A, with unpruned leaves was first, method B with one-half of the leaves pruned was second and method C with stem cut back to a height of 30 centimeters was last.

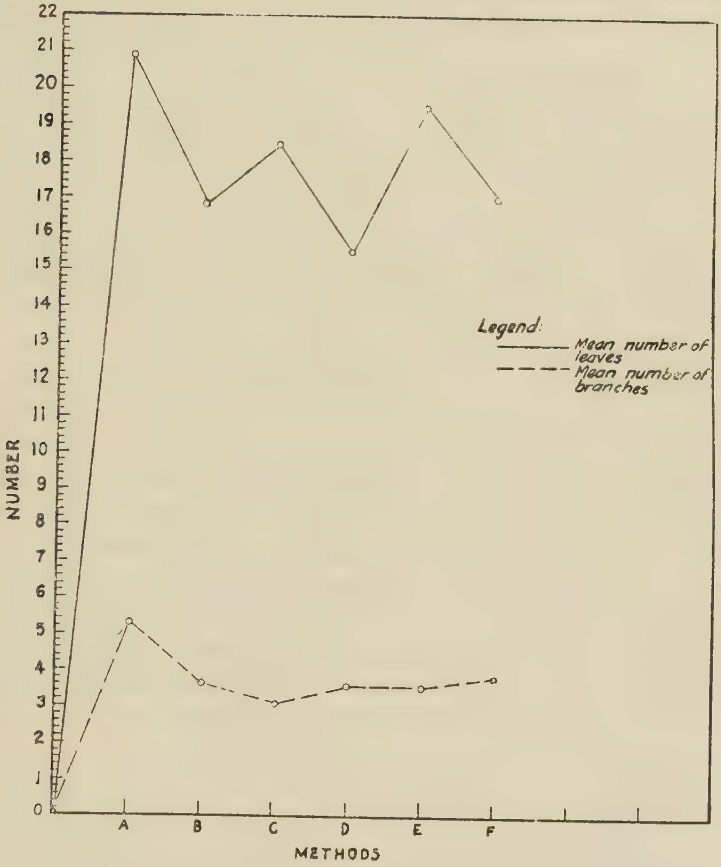

Chart 2.—Showing at the close of the experiment, the mean number of young leaves and branches on each living plant under each method of transplanting.

The second point is that where the roots of the seedlings were bare of earth, as by methods D, E, and F, the line rises toward the method where the seedlings contained less aërial space. The seedlings treated according to method F where they were cut back to a height of 30 centimeters gave the highest average number of branches. Method E was second and method D was third in the average number of branches. This result may be explained by the fact that since the roots of the seedlings in methods D, E and F were bare of earth and were to some extent injured, they drew less amount of water. It is evident that if the evaporating area is large (methods, D and E), the roots which can only draw a little or no water at all from the soil to begin with, can not balance the excessive rate of transpiration. As a result of this the plants either died or grew slowly (methods D and E). Therefore, in the case of bare roots the plants which have less transpiration surface have an advantage over those which have a larger transpiring area. The cutting back of the stem of the plants in method F greatly reduced their transpiring power and this reduction found expression in there being a higher percentage of living plants by this method.

The most striking point observed at the close of the experiment was that the method which involved the cutting of the stem back to a height of 30 centimeters (methods C and F) showed in both balled and unballed form in both plantations a higher percentage of living plants than in any other of the methods under study (see chart 1).

Method C, with cut stem, gave a higher number of living plants than methods A and B. This method may show that where the condition of the roots is the same when seedlings are transplanted, the one with less evaporating space has the greater chance to survive. This may also be true with the seedlings with bare roots. Likewise, the percentage of living plants in method F was much higher than with the plants treated according to method C.

It is rather interesting and contrary to the usual and common practice of nurserymen, that with the cacao seedlings fifteen to eighteen months of age, method (F) where the seedlings had bare roots gave a higher percentage of living plants than method C with balled roots.

Weaver and Clements (1929) stated that the maintenance of proper balance between root and shoot is of great importance. If either is too limited or too great in extent, the other will not thrive. This may be the explanation for there being more plants living by method F than by method C or by any other of the methods.

According to the same authors, in transplanting crops of various kinds, many of the roots of the young plants are unavoidably destroyed. Hence, the top must be pruned back or the plant protected from excessive water loss, until the balance between the absorbing and the transpiring system is reëstablished.

From the results of the first planting, and from the actual field observations of the performance of an individual plant by each method, method F, roots bare of earth and stem cut to height of 30 centimeters, was considered the best. This conclusion was based upon four important points: first, the percentage of living plants, second, the vigor of the plants, third, the feasibility of transplanting and fourth, the least expense involved in transplanting.

As a check on method F on a larger scale, 200 seedlings of about the same size from the seeds planted on April 14, 1932 were set out in the field in September and in November, 1933. To make the conditions uniform, the plants were set in the different parts of the field. They were all carried from the nursery to the field in damp sacks so as to prevent wilting as much as possible. Measurements of the height of the seedlings before setting them in the field and weekly observations and measurements were taken.

At the close of the experiment the percentage of living plants was 87. This success is surely far better than that by any of the other methods.

It is evident that from the success shown in the second planting of old cacao seedlings, method F was the best of the six different methods of transplanting used.

This method of transplanting cacao seedlings not only gave the highest percentage of living plants but also it was the easiest and the most feasible method of transplanting. The burden of balling, the load of carrying the balled seedlings to the field and the weight of the crown of the seedlings are eliminated in this method.

SUMMARY AND CONCLUSION

A total of 560 cacao seedlings at the age of fifteen months and bearing a height of 81.8 ± 2.2 to 94.5 ± 2.5 centimeters were used in this experiment. Six different methods of transplanting were performed; namely, method A, roots balled with earth and unpruned leaves; method B, roots balled with earth and one-half of the foliage cut off; method C, roots balled with earth and stem cut back to a height of 30 centimeters; method D, roots bare of earth and unpruned leaves; method E, roots bare of earth and one-half of the leaves cut off; method F, roots bare of earth and stem cut to a height of 30 centimeters.

The results obtained from this study may be briefly summarized as follows:

1. The least laborious, least expensive and also the most successful method of transplanting fifteen months old cacao seedlings is by cutting back the stem to a height of 30 centimeters and leaving their roots bare of earth.

2. In transplanting cacao seedlings from about fifteen to eighteen months old with either bare roots or balled with earth and unpruned leaves a low percentage of success may be expected.

3. When the seedlings were transplanted either with bare roots or balled with earth, pruning off one-half of the leaves did not prove as effective as cutting back the stem to a height of 30 centimeters.

4. Transplanting cacao seedlings fifteen months old should be done either with roots balled with earth or the roots carefully freed from soil and the stem cut back to a height of 30 centimeters so as to prevent excessive evaporation before the plant has become established in its new location.

5. The true merits of these different methods of transplanting as applied to cacao may probably be found more conclusively at the bearing age of the plants.

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TABLE 2

Showing the percentage of plants which showed leaves and branches at a certain number of days after transplanting

METHODS	PLACE PLANTED	NUMBER OF DAYS										TOTAL [a]
		21	28	35	42	49	56	63	70	77	84	
		per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	
A	College plateau	3.84	3.84	7.69	7.69	—	—	—	—	—	—	19.2
	Forestry land	2.29	11.76	2.94	—	—	—	—	—	—	—	17.6
B	College plateau	15.38	—	—	3.84	—	—	—	3.84	—	—	26.9
	Forestry land	8.83	—	8.83	2.94	2.94	—	—	—	—	—	23.5
C	College plateau	3.84	—	3.84	—	3.84	—	3.84	11.53	—	3.84	26.9
	Forestry land	8.83	5.88	8.83	14.70	—	—	5.88	2.84	—	—	47.1
D	College plateau	—	—	—	—	—	—	—	—	—	—	—
	Forestry land	—	—	—	—	—	—	—	—	—	5.88	5.9
E	College plateau	—	—	—	—	—	—	—	—	—	—	—
	Forestry land	—	—	—	—	—	—	2.94	5.88	2.94	2.94	14.7
F	College plateau	7.69	7.69	—	—	3.84	7.69	3.84	—	—	—	30.7
	Forestry land	—	—	29.41	2.94	8.33	23.53	8.33	—	—	—	73.5
Average		4.22	2.43	5.12	2.67	1.57	2.60	2.06	2.01	0.24	1.05	23.97

[a] Total taken from table 3 not included in this paper but filed in the Department of Agronomy.

NOTE: SECRETARY'S REPORT ON LOS BAÑOS BIOLOGICAL CLUB FOR 1934-35 [1]

With the one-hundred-and-second meeting on March 7, the twelfth year of the Los Baños Biological Club was brought to a close.

During the College year, 1934-1935, eleven meetings were held in which twenty-four scientific papers were read and discussed. With two exceptions, these papers were by members of the faculties of the College of Agriculture and School of Forestry. By departments the number of papers from the College were: Agronomy, 8; Animal Husbandry and Chemistry, 3 papers each; Botany and Engineering, 2 each; Entomology, 1; by visitors, 2. Three papers were presented by members of the School of Forestry faculty.

Two prominent guest scientists addressed the club. On June 26, 1934, Dr. Clarence Erwin McClung of the University of Pennsylvania discussed some interesting phases of his work on cytological studies on locusts. Before the meeting, a dinner was given by the members of the club in honor of Doctor McClung, Mrs. McClung and Dr. H. Irene Corey, Doctor McClung's research assistant. Forty-three members of the Los Baños Biological Club were present.

On August 30, 1934, Dr. Ira Condit, Pomologist from the University of California at Los Angeles, read a paper on "Studies on Figs".

The attendance at the meetings this year was considerably larger than in the past. Doctor Manresa [2] last year reported an average attendance of 20 members of the faculty and 38 students. The average attendance for 1934-1935 was 29 faculty members and 57 students.

Arranged by departments, the titles of papers presented before the club and their authors are here given.

College of Agriculture

Department of Agronomy

1. Experiments on harvesting of sugar cane, *Saccharum officinarum* Linn., by Dr. V. C. Calma. December, 1934.

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[1] General contribution from the College of Agriculture No. 492. Read before the Los Baños Biological Club on March 7, 1935.

[2] MANRESA, MIGUEL. 1934. Los Baños Biological Club. The Philippine Agriculturist 22: 607–624.

2. Studies on different kinds of seed pieces for commercial propagation of sugar cane, by Dr. V. C. Calma, C. Valera and I. Nuestro, March, 1935.
3. A genetic study of certain characters in varietal hybrids of cowpea, *Vigna sinensis* Endl., by Dr. J. M. Capinpin. January, 1935.
4. Methods of propagation of the macopa, *Eugenia javanica* Linn. with special reference to use of other species as stocks, by Dr. L. G. Gonzalez. June, 1934.
5. Top-working undesirable santol trees, by Dr. L. G. Gonzalez. July, 1934.
6. The introduction of *Nepheliums* in the College of Agriculture from Java, by Dr. N. B. Mendiola. October, 1934.
7. Twelve years of improvement of pineapple in the College of Agriculture, by Doctors N. B. Mendiola, J. M. Capinpin and Mr. T. M. Mercado. June, 1934.
8. Preliminary studies on the marcottage of the avocado, by Mr. A. San Pedro. October, 1934.

Department of Animal Husbandry

1. Studies on the physical qualities of the hen's egg: 1. Observation on new-laid Los Baños Cantonese eggs, by Dr. F. M. Fronda and Mr. D. M. Clemente. June, 1934.
2. Protein supplements in poultry rations: III. The optimum amount of shrimp meal to use as supplement in rations for growing chicks, by Dr. F. M. Fronda and Mr. A. E. Kabigting. November, 1934.
3. Studies on surra: II. Natural recovery from surra infestation among the taurine and bubaline species of cattle, by Dr. M. Manresa and Dean B. M. Gonzalez. February, 1935.

Department of Agricultural Chemistry

1. Studies on the thermal decomposition of coconut oil, by Mr. J. Banzon. November, 1934.
2. Clarification and preservation of toddy, by Dr. G. A. Guanzon. September, 1934.
3. Carbon-nitrogen ratios of some Philippine soils, by Mr. L. J. Villanueva and Mr. H. E. Lumang. February, 1935.

Department of Agricultural Engineering

1. A study of grading and combining aggregates to obtain maximum voids for concrete work, by Mr. E. M. Bautista. December, 1934.
2. Performance characteristics of alcohol, alcohol-gasoline blends, and gasoline as motor fuels under different road conditions, by Dr. A. L. Teodoro, Prof. A. B. Catambay, Mr. E. K. Ongsansoy, and Mr. J. P. Mamisao. March, 1935.

Department of Entomology

1. Tolerance of mealy bugs to drying of host tissue, by Dr. L. B. Uichanco. October, 1934.

Department of Plant Physiology

1. The anatomy and morphology of the buñga, *Aeginetia indica* Linn., by Dr. J. B. Juliano. July, 1934.
2. Effects of heat upon the viability of buñga seeds, *Aeginetia indica* Linn. by Dr. R. B. Espino and Mr. F. Pantaleon. August, 1934.

School of Forestry

1. Financial result of ipil-ipil plantation, by Mr. N. Lalog. December, 1934.
2. Study of diameter growth of eight species in Maquiling National Park, by Mr. J. Seguerra. September, 1934.
3. Notes on poisonous plants in Mount Maquiling and vicinity, by Mr. M. Sulit. January, 1935.

L. G. Gonzalez
Of the Department of Agronomy

ABSTRACT[1]

Field test of twenty varieties of cassava. OCTAVIO ALZONA. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 451; Experiment Station contribution No. 1030.*)—The author studied twenty varieties of cassava for starch yield, percentage of starch, and their adaptability as a crop in the College of Agriculture, Laguna.

The varieties used in this experiment were obtained from the Bureau of Plant Industry Experiment Station at Lamao, Bataan. They were named Angular, Bacuit, Baker, Begog, Cassava White, Colored or Red, Copeland, Isidro, Jolo White, Jose, Kapō White, Kapo Colorado, Lempeneng, Red Manila, Red Native, Salinas, Sinkong Manis, White Native, White Smooth, and Woengal.

The author based his descriptions on color of leaves, veins, stems, bark, the bending of leaves, and the ratio of width to length of middle lobe of leaf. He used for planting stem cuttings 25 cm. long from plants six months old. All the varieties were planted in furrows and each variety was represented by 55 hills, with one cutting in each hill.

Computation was made on the number of cuttings from each variety. Starch was extracted in the starch factory of the Agronomy Department. The hydrocyanic acid content of the cassava root was determined.

The following results were obtained by the author:

1. The Woengal variety had the highest percentage of germination, being 93.2 per cent, followed by Red Native with 92.1 per cent, Colored or Red, 90.6 per cent, and Copeland, 90.0 per cent.

2. White variety had the lowest percentage of germination, being 60.4 per cent. The percentage of germination of the rest of the varieties ranged from 81.3 to 89.4 per cent.

3. The average production per hectare of the 20 varieties studied was 10.08 tons, compared with 27.47 tons in Lamao.

4. The Salinas proved to be the highest yielding variety; it gave 23.0 tons per hectare.

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[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

5. The percentage of starch extracted by factory method was highest, 28.7 per cent, with Cassava White; second highest, 24.05 per cent, with White Smooth; third highest, 23.33 per cent, with Isidro; and the lowest, 11.69 per cent, with Kapo White. The yield of each variety in terms of roots was very low, compared with the yield in the Lamao Experiment Station.

6. Jolo White contained the largest amount of hydrocyanic acid (HCN), the greater portion of which was extracted from the bark of the roots, as is true with any variety of cassava.

7. Not a single variety proved highly toxic.

Abstract by Serapio Singson Ardonia

CURRENT NOTES

Among the raw materials of a fatty nature, milk is the principal constituent of margarine. It gives the margarine two important properties: taste and odour. The majority of raw materials used in the manufacture of margarine are absolutely tasteless and odourless. This is above all the case with refined oils at the present day. It is from milk, treated in a special way, that margarine receives the desired taste and odour which causes it to resemble butter. The quality of butter, and chiefly its taste and essentially butyraceous odour, depends on the acidifying or ripening of the cream. Accordingly the margarine industry only employs milk acidified in a certain way, usually skim milk or serum. Skim milk is used, as the fat of whole milk has not an important influence on the improvement of the taste and odour and it is better to use the relatively costly cream for butter making. Serum is often used to avoid a component of milk (casein) which considerably diminishes the stability of the margarine. An artificial milk is also often used constituted by a simple solution of sugar in which the bacteria develop which cause acidification or ripening. In this case, however, it is not possible to have the taste and odour of natural milk. Lately, the use of dried milk has greatly increased in the margarine industry as since the introduction of modern processes of desiccation, dried milk bears a much closer resemblance to natural milk in respect to odour, taste and solubility. For the margarine industry chemical analysis of milk relates to: contamination, fats, dry matter, acidity and antiseptic substances. Bacteriological examination concerns: presence or absence of injurious bacteria, the age and resulting treatment of the milk.

International Review of Agriculture (Rome), January, 1935.

There are a large number of fruits suitable for cultivation in Malaya. One writer enumerates 39 principal fruits for cultivation, 47 fruits of less importance, 44 indigenous fruits, infrequently cultivated, but collected and eaten by Asiatics, and 5 fruits suitable only for growing on the hills in Malaya.

There is a very considerable import of fruits into Malaya. In 1933, over 8,000 tons of fresh fruits and about 4,000 tons of dried and preserved fruits were imported. Most of these imports are of varieties which are unsuited for cultivation in Malaya. At the same time, it is possible that if the locally produced fruits were of better quality and if supplies were more regular, the demand for imported fruits would be less.

The Malayan Agricultural Journal, March, 1935.

Experiments are being made in Calcutta with a view to the cheap production of a motor spirit from the Water Hyacinth plant (*Eichhornia*), which grows very abundantly in the waterways of Bengal as well as in lakes, ponds and streams in most tropical countries. By bacterial decomposition, about 24 gallons of motor spirit can be obtained from one ton of the plant, at an approximate cost of 0.5 pence per gallon. During the process, a gas of hydrocarbon nature is released; this presumably might be used as a combustible material for distilling off the spirit. The solid residue after fermenting is said to furnish an excellent manure.

(*Chemistry and Industry,* 1934.)
Reprinted in *The Planter,* September, 1934.

Concerning the locust plague in South Africa, it appears that the responsible Minister had for some time pinned his faith to the dissemination of a certain fungus disease as a means of destroying the insects; but this apparently had proved abortive, and the distribution of arsenical powder was again resorted to. As illustrative of the magnitude of these operations it may be mentioned that at one place 800 men were set to work to hold up the invading swarms coming from the north. It was estimated that the control of locusts in certain areas had cost the Government a quarter of a million sterling in the past six months, and this with very little improvement in the situation. The next move was to dust the powder from aeroplanes, which was estimated to cost £25,000.

As for private enterprise, it is mentioned that planters are advised to see that poisoned baits consisting of molasses and arsenic on the bagasse is spread in their canefields in order to minimize egg-laying. One of the sugar companies, using poison baits and spraying, has also adopted the method of burning the cane, by which means millions of the hoppers have been destroyed. In spite of all efforts, numbers of locusts were again infesting the cane.

The Australian Sugar Journal, October, 1934.

COLLEGE AND ALUMNI NOTES

One of the general meetings of the Third Philippine Science Convention was held in the College Auditorium on March 1, 1935, with Dean B. M. Gonzalez presiding. The principal address was by Prof. Harley Harris Bartlett, Head of the Department of Botany in the University of Michigan. Professor Bartlett is this year in the Philippines as exchange professor in the University of the Philippines. His subject was "Nationalism, Imperialism and Sphere of Influence in Natural Science".

The speaker took his audience with him on a speedy tour over the globe with a new line of attraction, that of the relation of a country's progress to its interest and achievement in botany. Professor Bartlett's charm and skill as a speaker added much to the tour, which of itself was of extraordinary interest.

Among the technical papers read was one on the surra outbreak in 1934 in the College by Dr. Miguel Manresa.

The seventh program for initiating new members in the Society for the Advancement of Research (SAR) was held in the College Auditorium on February 21. As is usual, the program was preceded by a dinner at Molawin Hall given by the members to guests and the initiates.

At the initiation program Dr. F. O. Santos, the president of the SAR, presided. The address of the evening was by President Bocobo who was introduced by Dean Gonzalez.

Of the new members, three are members of the Sigma Xi

Dr. Valeriano C. Calma, Iowa State College Chapter
Dr. Silverio M. Cendaña, California Chapter
Dr. Hilario A. Roxas, Chicago Chapter

Three were elected;

Dr. Walfrido de Leon, School of Hygiene and Public Health, University of the Philippines.

Prof. Antonio P. Racelis, School of Forestry, University of the Philippines.

Dr. Teodulo Topacio, Bureau of Animal Industry.

There are now thirty-three active members and fifteen associate members in the SAR.

Dr. R. B. Espino, head of the Department of Plant Physiology has the distinction of being the first exchange professor from this College.

Doctor Espino was invited by Lingnan University, Canton, China to occupy the position as exchange professor in plant physiology from March 14 to June 10, 1935.

Mr. Pablo N. Mabbun '23 who, as University Fellow, has been studying in the United States returned to the College on April 4. Mr. Mabbun received the degree of Doctor of Philosophy in Economics from the University of Wisconsin in January, 1935. He returned home by way of Europe. While in Berlin he met Prof. Max Sering, through a letter of introduction from Professor Hibbard, his major professor in Wisconsin. Professor Sering, of the Department of Economics of Berlin University, is the second vice-president of the International Institute of Agricultural Economists. He invited Mr. Mabbun to become a member of this organization as no Filipino is representing the Islands in the Institute. Mr. Mabbun made observations on the economic conditions in Germany, Switzerland, and Italy during his stay in Europe.

Doctor Mabbun taught Rural Economics IV in the Summer School. For this coming College year he will teach marketing, including agricultural cooperation, in the Department of Economics.

In the Carnival Live Stock Show, Dr. Valente Villegas was on committee on judging horses and Dr. F. M. Fronda was Chairman of committee on judging poultry.

Mr. José Velmonte, Head of the Department of Rural Economics recently received a letter from the Director, Department of Agriculture, British Guiana, and also one from the Agricultural Superintendent in the same department, each asking for copies of the schedules or questionnaires devised in the department for tenancy survey and also for copies of Philippine rural credit laws. These requests were made after reading Mr. Velmonte's article in the Silver Jubilee Number of THE PHILIPPINE AGRICULTURIST.

Mr. G. M. Goodall of the International Harvester Company was a Campus visitor in March. The next week, he left for the company's landholdings in Davao where, it is reported, the company expects to carry on experiments on the culture of derris for the production of rotenone and of papaya for the extraction of papain. Mr. Goodall was shown around the Campus by Dean B. M. Gonzalez.

Mr. Moises M. Kalaw '26 was on the Campus in April noting the changes since he was last here five years ago, and making old friends glad by friendly calls. Mr. Kalaw is instructor in botany in Northern Junior College at Vigan. This summer he will take work at Puerto Galera with Dr. H. H. Bartlett, exchange professor from Michigan University.

One of our pioneers, Mr. José Dacanay '15 was a welcome Campus visitor in April. Mr. Dacanay, formerly with the Bureau of Plant Industry, is now with the Oriental Publishing Company.

The Department of Agronomy recently received 63 boxes of Official Cotton Standards from the United States Department of Agriculture. These standards will be used for future classification of cotton grown in the Philippines.

The one-hundred-and-second regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Poultry Building, College of Agriculture, on Thursday, March 7, 1935, at 7:30 p. m.

The following papers were read and discussed:

1. "Studies on different kinds of seed pieces for commercial propagation of sugar cane"

   By Dr. V. C. Calma, C. Valera and Isaac Nuestro.

   Paper was read by Doctor Calma.

1. "Performance characteristics of alcohol, alcohol-gasoline blends, and gasoline as motor fuels under different road conditions"

   By Dr. A. L. Teodoro, Prof. A. B. Catambay,
   Mr. E. K. Ongsansoy and Mr. J. P. Mamisao.

   Professor Catambay read the paper.

   Annual Report of the Secretary was read.

In the election which followed, Dr. A. L. Teodoro was elected president and Mr. Ricardo Buhay of School of Forestry, secretary. Remarks by the retiring president closed the last meeting of the year.

The Baker Scholarship was awarded this year to Fernando T. S. Torres. Mr. Torres first matriculated in the College of Agriculture in June, 1929, presenting as credentials a diploma from the Manila East High School. At the close of the first semester of the College year 1934-35 Mr. Torres' average of all grades in all courses was 2.459. This is a most creditable scholarship record for a self-supporting student. Throughout his college course he was employed as a student laborer in the Department of Chemistry. This continuity in a job, in itself, is a recommendation for character. Obviously, Mr. Torres meets most satisfactorily the basis on which the Baker Memorial award is made. This is "character, promise of future usefulness, and scholarship". Only self-supporting seniors are eligible. There were nine applicants for the scholarship this year.

The "Joaquin J. Gonzalez" medal was awarded to Felix de Leon Flores. This medal is awarded to the graduate having the highest scholastic record. Mr. Flores' average for 191 unit credits was 1.93. Dominador Batenga ranked second with 2.28 average for 191 unit credits, and Fernando T. S. Torres third with 2.47 average for 188 unit credits.

The only contribution to the Baker Memorial Fund this year was Three Pesos. This contribution was obtained by the sale in the English Office of left-over *Farm Leaves*, the 1933 publication of the Aggie Pen Club.

The award from this Fund this year to the successful candidate was ₱126, a welcome help to a self-supporting senior.

Mr. Dai Eto of the Rice Inspection Office, Government General of Taiwan visited the Department of Agronomy on February 21. He was interested in rice and conferred with Prof. Vicente B. Aragon.

Among the recent visitors to the Department of Agronomy who were interested in coffee, cacao, copra and in soap making and brush manufacture were; the Balayan Institute of Balayan, Batangas under the leadership of Miss S. Ramos; Mr. Pedro Pereyra '27 together with the barrio lieutenants of Lucban, Tayabas and Mr. J. V. Pagapas of the Tanauan Institute, Batangas. They were given demonstrations on brush and soap making by Dr. Pedro A. David.

Messrs. Gow R. Coleman and Yang Sih-zung both of the Elbrook Inc. of New York were recent Department of Agronomy visitors. Mr. Coleman is the vice-president of the company with an office in New York and Mr. Yang is the manager of the Elbrook branch in Tientsin, China. They came to the Philippines as representatives of the Whitin Machine Works Company of Whitinsville, Mass., the company that manufactures cotton ginning machines, looms and other machinery for cotton work.

The Secretary's office reports that the following College of Agriculture students received degrees on March 26, 1935.

Ad Interim

Bachelor of Agriculture

1. Leopoldo A. Alicbusan (June)
2. Constante V. Valera (June)
3. Macario M. Allas (October)
4. Alvaro F. Asuncion (October)
5. Guillermo B. Bumagat (October)
6. Alberto C. Felix (October)
7. Francisco B. Lopez (October)
8. Ruperto F. Olivar (October)
9. Pablo S. Padilla (October)
10. Arcadio P. Piamonte (October)

Bachelor of Science in Agriculture

1. Alfredo V. Andam (June)
2. Venancio C. Duarte (June)
3. Gregorio A. Jayme (June)
4. Francisco G. Reformina (June)
5. Raul Ruiz de Arana (October)
6. Vicente B. Arancillo (October)
7. Felix B. Briones (October)
8. Julian M. Bulanadi (October)
9. Francisco L. Calimbas (October)
10. Macario P. Corales (October)
11. Emeterio P. Dolores (October)
12. Simeon A. Estocapio (October)
13. Restituto P. T. Felipe (October)
14. Victoriano J. Madrid B.Agr. (Supp.) (October)
15. Leoncio M. Meneses (October)
16. Alberto S. Ramos (October)
17. Exequiel B. Ramos (October)
18. Teofilo B. Rivera (October)
19. Alberto D. Santos (October)
20. Phanom Smitananda (October)
21. Cesar S. Tolentino (October)
22. Pedro S. Yadao (October)
23. Bonifacio T. Yñiguez (October)

Certificate in Agricultural Education

1. Julian M. Bulanadi B.S.A. '35 (October)

Completing work in March, 1935

Bachelor of Agriculture

1. Pablo L. Aala
2. Marcos J. Aldama
3. Melecio P. Baltazar
4. Segundino O. Barraquero

5. Ambrosio P. Bayan
6. Aurelia M. Capinpin
7. Fausto H. Fermin
8. Mariano S. Macasaet
9. Inocencio C. Manzo
10. Maxima B. Mulimbayan (Baker Scholar, 1934)
11. Felix N. Natino, Jr.
12. Fernando de los Reyes
13. Petronilo B. Rosales
14. Pedro B. Tiambeng

Bachelor of Science in Agriculture

1. Anselmo P. Afalla
2. Proceso E. Alcala, B.Agr. (Supp.)
3. Jose Q. Amores
4. Pedro M. Asico
5. Felipe T. Bañez
6. Porfirio V. Barlaan, B.Agr. (Supp.)
7. Alfredo V. Barrera
8. Santos A. Belo
9. Esteban Cada
10. Felicidad Y. Chan
11. Tomas G. Collado, B.Agr. (Supp.)
12. Artemio G. Cruz
13. Banao Dalid
14. Melecio S. Duran
15. Floro B. Flores
16. Dionisio P. Garzon
17. Flavio G. Gonzalez, B.Agr. (Supp.)
18. Paulino A. Guerrero
19. Jesus de Guzman, B.Agr. (Supp.)
20. Victor M. Juan Jr.
21. Virginio C. Juan
22. Wilfredo V. Macapagal
23. Pablo C. Macariola
24. Mariano V. Magtang
25. Alfonso S. Marcelo
26. Osmundo Mondoñedo, B.Agr. (Supp.)
27. Pantaleon P. Opeña
28. Fernando C. Ricerra
29. Hilarion S. Savella
30. Fabian V. Solpico
31. Getulio B. Viado, B.Agr. (Supp.)
32. Robert R. Walz

Bachelor of Science in Sugar Technology

1. Dominador E. Batenga
2. Hugo B. Fernandez
3. Cenon R. Flor-Cruz
4. Felix de Leon Flores (Bailon de la Rama Scholar)
5. Lazaro S. Gonzales
6. Florencio Z. Ligon
7. Paterio G. Melgar
8. Fernando T. S. Torres (Baker Scholar, 1935)

Certificate in Agricultural Education

1. Porfirio V. Barlaan, B.S.A. '35
2. Numeriano Cuevas, B.S.A. '33
3. Banao Dalid, B.S.A. '35
4. Virginio C. Juan, B.S.A. '35

HERE AND THERE IN SOUTHERN, CENTRAL, AND NORTHERN LUZON[1]

FROM THE NOTEBOOK AND CAMERA OF A SOIL TECHNOLOGIST

INTRODUCTION

It was in the course of several field trips in Luzon, made in company with James Thorp, for fourteen years a member of the soil survey staff of the United States Bureau of Chemistry and Soils, that new light was shed upon many of our important soil series and broader soil groups.[2] For the benefit of Mr. Thorp as well as of the progress of soil science in these Islands, an endeavor was made to see within the very limited time available, as many as possible of the different soil conditions which exist. While the technical observations and results will be elsewhere recorded, some of the byproducts, so to speak, of those trips seem of sufficient general agricultural interest to warrant space in our journal.

THE MAQUILING—BANAHAO VOLCANIC REGION

While our College is located in this most interesting volcanic region, perhaps we do not often pause to realize that we live not

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[1] General contribution from the College of Agriculture No. 494. Received for publication April 10, 1935.

[2] After the writer, in 1933, found it impossible to continue as Chief Soil Technologist of the National Geological Survey of China, that Survey obtained on leave from the United States Bureau of Chemistry and Soils Mr. James Thorp to carry on the work in China. He visited our Campus during the latter part of January and early February of this year, primarily to consult the writer regarding certain soil classification and survey report problems which had arisen in the course of the work in China. In addition, with his extensive field experience in many parts of the United States, including four winters spent in detailed soil survey work in Puerto Rico, Mr. Thorp was of great assistance to us here. As an aid in interpreting our broader soil groups, we were able to show Mr. Thorp various local soil types and to obtain his opinion as to the resemblances of certain of our soils to West Indian and other broad soil groups of the world. In making the field trips with Mr. Thorp, Director A. S. Argüelles of the Bureau of Science was most helpful in arranging for official transportation and lending Dr. M. M. Alicante to accompany us on the main field trip to the north. Localities visited included the Maquiling and Banahao regions of Laguna and Tayabas provinces, Novaliches and Alabang in Rizal, various localities along the main (Tarlac) route to Baguio, along the Mountain Trail from Baguio nearly to Bontoc, from Sabangan west through Cervantes to Taguidin on the coast, south through San Fernando, Bauang, Dagupan and thence westerly through Lingayen to Alaminos, and south along the Zambales west coast to Subic and Olongapo, and finally back across Bataan Peninsula, through San Fernando Pampanga, to Manila.

only in a region of rare scenic beauty but that it is also a region of unusual scientific interest not often surpassed by other localities. For the pedologist the region is of particular interest as being one of very young soils, as the repeated falls of volcanic ash have many times rejuvenated the soils. Doubtless this is connected with a local saying in Tanauan, on the western side of Mount Maquiling, that the orange groves of that locality do well as long as Taal volcano smokes.

Our climate during the season of trade winds, from November to April, because of the lack of high mountains to the east-northeast, is considerably more moist than other places more protected. And the summit of Mount Maquiling, though it is hardly more than 1,000 m. elevation, shows the effect of the moisture brought by the trade winds, in that the soil on the summit is of the same type as that on the peaks, shielded from the moist trades, but more than twice its height in Benguet Province.

East of our campus, in the Dayap—Santa Cruz region there are several low ridges, more or less continuous and roughly parallel to each other and to the lake shore. On these slight elevations are the coconut groves and the barrios, between are the lowland rice fields. It was a satisfaction to have confirmed the writer's belief that these ridges were remains of older, higher shore lines of Laguna de Bay.

Beyond Lucban town, extending out from the northeastern slopes of Banahao de Lucban, north for many kilometers and east to the Pacific, is a region with a relatively uniform elevation of the uplands of a little more than 400 m. (about 1,400 ft.) This region seems to have been a peneplain, elevated at the time the principal movement along the Pagsanjan fault occurred. During the winter season the moisture laden trade winds easily cross these low mountains, bringing rain practically daily. The highway cuts from Luisiana to Lucban, and north toward Sampaloc give an excellent section across series of soil profiles of this upland.

The nearly continuous rainfall has deeply weathered the soils, giving them a grayish or brownish yellow color on the surface, and quite a bright red below. The plant food has been leached away and eroded off, accounting for the low fertility of these uplands. On many of the knolls are coconut groves or closely cropped permanent pastures. The latter are a conspicuous and rather unusual feature of the landscape. In many of the depressions are shallow ravines; between the low rounded hills are rice fields, often very small. Elsewhere, are grassy bogs and small swamps in the depressions. Rice seed beds are on the steep slopes, irrigation for the germinating rice being unnecesary because of the daily rains. Giant pandans, at times in plantations, supply the raw material for making country hats, bags for local use, and large mats. Forest destruction, even along the more recently opened portions of the Sampaloc road, is almost complete; very few of the original trees still stand.

Along the Sampaloc road, from the Lucban uplands dropping down to Sampaloc, were abundant evidences of the extraordinarily heavy rainfall of some months previous, when during a typhoon, in 24 hours more than 600 mm. (26 inches) of rain fell.[3] Numerous landslides occurred on the steep mountain sides, carrying vast quantities of soil and debris to the river valley. Sediment and driftwood had been strewn over the lowland rice fields in the plain, seriously injuring the land, but worse than that, the flood which carried this material caused considerable loss of life through destruction of barrios along the banks of the river.

Lucban town itself is a quite unusual town; even the inhabitants seem to have a different cast of features from those usually seen. In this town of buntal hat weavers, many of the houses have roofs thick and black, made of cabo negro palm (*Arenga saccharifera* Labill) fiber, beautifully set off by quantities of green moss and growing ferns. Some of these thatches are reputed to be over a hundred years old, so durable is the fiber. Along one side of each street is a masonry channel through which rushes a stream of clear water, most useful for washing clothes or the quantities of locally made buntal hats; on the opposite side of each street is a drain or gutter for waste water.

While the topography of this Lucban—Tayabas region is irregular and difficult to traverse, even the Spanish had roads here, with some very beautiful bridges. We came upon a very heavily buttressed bridge upon the little used Tayabas—Pagbilao road.

Pagbilao town is at the eastern edge of a considerable body of only slightly sloping soils, heavy in texture and seldom cultivated. These soils lie about 30 m. (100 ft.) or so above sea level and extend north only a few kilometers from the coast. Lucena is just beyond the western boundary of these soils. The supposition is that these soils were formerly under the sea and had been acted upon and impoverished by the sea water, followed by leaching after the land had been elevated to its present position.

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[3] This measurement was reported from the hydroelectric power plant at Botocan, a few kilometers southwest of the region under discussion.

West of Lucena town and across the west branch of the river there, toward the high school, the road cut shows under several meters of a relatively very uniform deposit of moderately compact volcanic ash tuff this same Pagbilao poor soil. It is this only slightly weathered ash which forms the richer soils which extend with little interruption from Lucena all the way to Manila. One of these interruptions in the volcanic ash soil is where the wash of the Lagnos River, arising in the broken out crater of Banahao, flows south across the highway, carrying well on toward Tayabas Bay an enormous mass of gravel, sand and bowlders.

It is probably the same volcanic ash which covered the whole country about Banahao. In the rainy Tayabas and Lucban region the ash has given rise to a reddish soil, about less rainy Calauan and Los Baños a brown soil, while about Candalaria, in the rain shadow of Banahao, the soils are a dark brownish gray, almost a black. These are very similar to the dark colored soils in the lowlands of Cavite and Rizal, where during half the year the rainfall is scant.

Novaliches Region, Rizal

Northeast from Manila, along the Novaliches road, there are numerous pits where the volcanic tuff is excavated and shaped for building purposes. Banks of some of the more recently excavated pits show extraordinarily fine sections down through the old rice paddy soil, through masses of iron concretions, and into the practically unweathered tuff material.

Further northeast, especially beyond the town of Novaliches, are the older, more thoroughly weathered, poor, reddish brown to red soils. Not only do these soils seem to be very poor in plant food materials, but the astonishing uniformity with which almost all the mango trees on the Mango Station had been blown over in a recent typhoon, indicated a physical deficiency in the soil, resulting in a lack of satisfactory root hold for the trees.

While there was no opportunity to take Mr. Thorp farther north, a previous visit which the writer made to the Salacot region north of the Angat River, revealed that a thorough study of the soils and weathering processes in that region would be of definite value in increasing our knowledge of the processes involved in the development of Philippine soils.

THE CENTRAL PLAIN

The Manila North Road starts out from the city across the extension of the same bodies of gravels as are farther east in the Novaliches region. The relatively poor soils of the upland between the aerdrome and the Balintawak monument are characteristic. These higher soils, while they extend far up the eastern side of the central plain, were not seen along the main road Mecauayan, as the highway here starts northwest across the coalesced deltas of the Angat and Pampanga rivers. Where drained, these delta soils tend to be a brown, although the lower annually submerged rice soils are frequently a dark gray color.

Between Guiguinto and Quingua many of the fine old mango trees are seriously ailing. It is suspected that there is a close relation between this unfortunate condition and the annual increasing length of time during the past few years when in this locality the water table is high. This additional water is due to the greatly increased amount of water brought on to these lands by the Angat irrigation system.

Near San Fernando, Pampanga, the highway passes on to the lower slopes of the deposits from the mountains to the west of the central valley. These soils on the western side of the valley are distinctly sandier and frequently gray in color. This sandiness seems to be a rather general characteristic of the material eroded from the rugged Cabusilan or Zambales mountains to the west. In fact, the streams flowing west through Zambales Province to the China Sea carry similar sediments. These light soils extend for a long distance north, to beyond Tarlac, and it is easy to understand why sugar cane in the last decade has proved a popular crop.

North of Paniqui the soils become heavier and darker in color, as the center of the valley is approached. And toward Binalonan the increasingly varied and irregular and confused character of the soils and drainage call especially for a soil survey of this plain of the Agno River, if the region is to be used most effectively for agriculture.

BAGUIO AND TRINIDAD VALLEY

While this attractively laid out, clean town with its invigorating climate never ceases to arouse enthusiasm, the writer's interest was centered on getting a new interpretation of the soils of the locality, two important soil series of which already have been described.[4]

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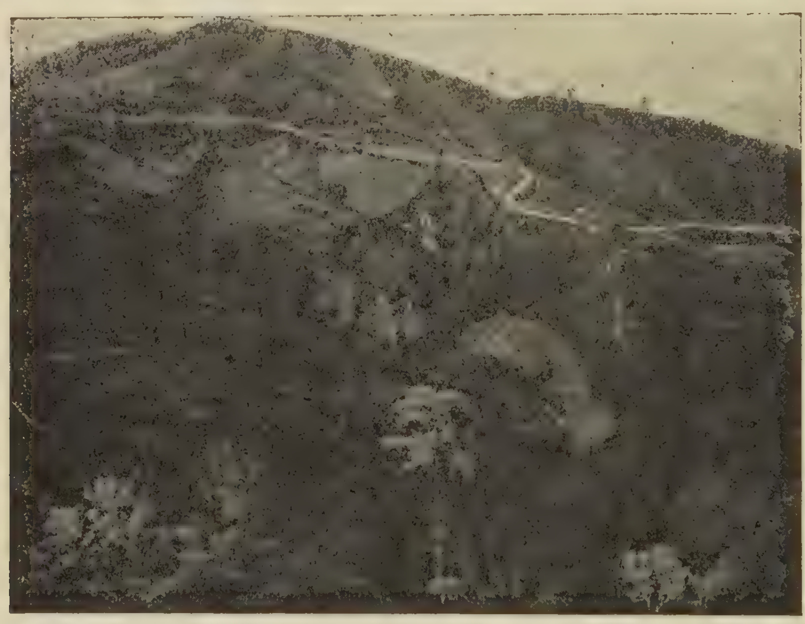
[4] ROBERT L. PENDLETON, AND DIONISIO I. AQUINO. 1932. Soils of the Bokakeng Forest Management Project, Baguio, Mountain Province. THE PHILIPPINE AGRICULTURIST 20: 500–510.

The Baguio-Trinidad Valley region has been studied geologically by a number of authorities, one of whom, Dickerson,[5] devoted particular attention to the physiography, showing it to be a remnant of a peneplain. Be that as it may, the much less steep topography of the locality has permitted the development of soils to a much more advanced stage of chemical transformation than has been the case in most of the mountains in that region at that elevation. Weathering has been deep, with the consequent removal of most of the plant food materials—naturally, most of the residents who have flower gardens about their homes in Baguio complain of the poverty of the



Photograph by Robert L. Pendleton

SOIL AND FOREST RESOURCES HAVE SUFFERED SADLY IN BENGUET

Fig. 1.—From not only the gently sloping land but also from some of that very steep, the forests have been stripped to permit of cultivation, and also to supply mine timbering. Around the cultivated fields and along the trails erosion is quite serious, with, in addition landslides, especially on the higher portion of the farther ridge. The surface soils are gray, particularly those on the steep, lower clearings on the north-facing slope; the road cut shows the white subsoils. On the small nearly flat summit of the hill the subsoils are somewhat red. About 20 km. north-east of Baguio. Elevation about 1,500 m. (5,000 ft.). February, 1935.

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[5] ROY E. DICKERSON. 1923. The development of Baguio plateau: a study in historical geology and physiography in the Tropics. Philippine Jour. Sci. 23: 413–453.

soils. The rainfall through the ages has not left much plant food, and there have been no rejuvenating ash falls in recent times.

The Forestry management policy of the Bureau of Forestry continues in Baguio to demonstrate its wisdom; the groves and almost solid forests of young seedling pines, are excellent results of the requirement that during logging at least one seed tree per hectare must be saved. The prevention or control of forest fires has already permitted rapid development of dense stands of trees, so that areas logged less than 20 years ago are now being thinned for mine timbers; only a few years more and the trees will be ready for conversion into lumber.

Studying some of the soils in detail we found, as was the case in other places, that soils derived from and lying only a few decimeters above a parent limestone rock were acid. In the limestone hills of the Mirador series of soils was much more grass and fewer pines than on the soils of the Baguio series. This latter series, the common one of Baguio proper, was said by Mr. Thorp to be very similar to the high mountain soil of Puerto Rico.

While the recent alluvial soils of Trinidad Valley are of only moderate interest to the pedologist, as they are too young to have had a profile development, these soils are of great economic interest and value, since in Luzon this is the only accessible agricultural land at this elevation, hence the only place, where on a considerable scale, temperate zone vegetables can be produced. That the land is greatly in demand and very limited in area is indicated by the very high rental figures: ₱200 per hectare per year for bare land had been common for years; during this visit we were informed that as high as ₱1,000 was being obtained. It was apparent that large quantities of fertilizers were being used by the gardeners, and they were exercising great care in the cultivation and protection of these gardens. Igorots, Filipinos and Japanese are the principal groups engaged in gardening. It was particularly noticeable that the farm yard manure and compost heaps were carefully protected against the weather, usually they were under sheds having a tight roof and good walls. Ashes are used in large quantities for fertilizing the gardens, and even tens of kilometers from Trinidad Valley forest litter is gathered together, burned, and the ash carried to the Valley for sale as a fertilizer.

"THE BABUIO-BONTOC TRAIL"

Of course the soils continued to be our chief interest. On the occasional, small, only slightly sloping hilltops, where erosion had not been so active, the deeper portions of the soils are red, as are those of Baguio. But on the steep slopes, while the immediate surface soil material is a gray to light grayish brown, and it so appeared in the dry cultivated fields of the Igorots, deeper road cuts and larger landslides showed the soil proper to be very shallow, lying on light colored more or less kaolinized rock. The slope of the surface in this mountainous region is almost without exception so steep that ordinary upland mature soils cannot form (fig. 1).

The erosion of the soil *outside* of the cultivated Igorot fields seems to be more serious than that inside, because of the local custom of protecting the crops by surrounding the fields, even on steep slopes, by earth walls, with a ditch on the outside. The wall and the ditch concentrates the surface runoff, and in various places the erosion developed from that start has been serious (fig. 1). Erosion of the paths about the most of the Igorot villages is very common. It is particularly noticeable because the red subsoil of the less steeply sloping spots where the villages are located is so often exposed. Fortunately, however, the areas affected by erosion do not seem to increase very rapidly.

Here and there, in the distance, at the end of a long white line around the hills which indicated a trail or road, were seen the gashes in the mountain side marking the development of some mine. One's imagination is stirred by the reports of large quantities of gold being extracted, but at what a cost! Vast quantities of mine timbering are needed, and while many of the workings are permanent the very short life of mine timbering under Philppine conditions makes imperative rapid replacements, at least every two years.[6] The relatively heavy demands for lumber for surface and underground building construction also seriously increase the drain upon the pine forests of the province.

While on the northern slopes, especially of the higher mountains, relatively small sized hardwoods predominate, the principal and almost only timber tree in Mountain Province is the Baguio pine (*Pinus insularis* Endl.). Where untouched, these pine forests form beautiful stands of relatively large trees, sometimes more than a meter in diameter breast high. The general practice among the mountain peoples seems to be to annually, during the dry season, burn the grass and leaves under the trees, that the pasture may be improved. It was distressing to see as we drove through the Mount

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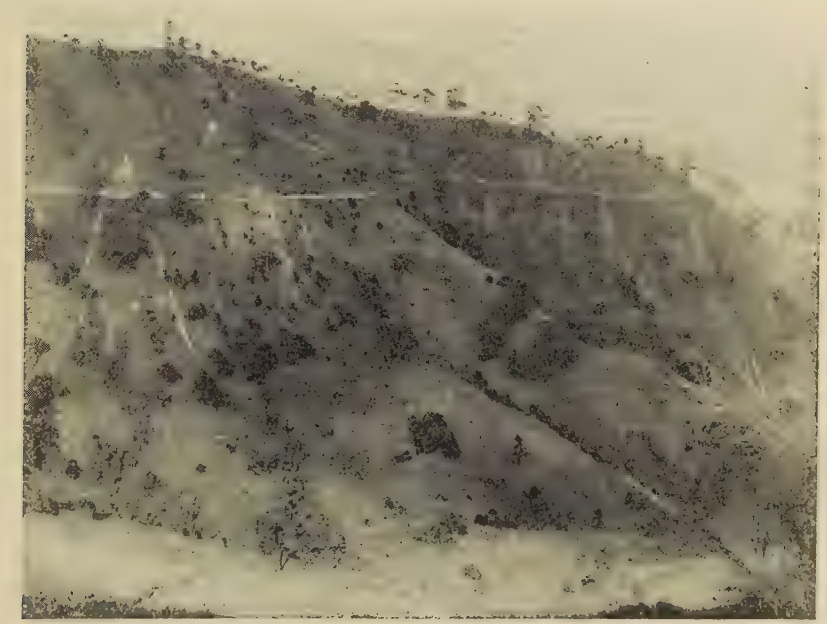
[6] LUIS J. REYES. Wood widely used in mines. Manila Daily Bulletin, February 1, 1935.

Data National Forest after dark a ground fire burning along a front of many hundreds of meters. The unfortunate thing about this burning is the destruction of the seedling pines, preventing regeneration of the stand (fig. 2). As already noted, near Baguio the careful exclusion of fire from the forests, together with the saving of seed trees in the earlier logging operations has proved the real merit of these practices in perpetuating the pine forests and their valuable timber supply in these regions.



Photograph by Robert L. Pendleton

STEEP NEARLY TREELESS SLOPES ON THE WESTERN SIDE OF THE ABRA RIVER VALLEY

Fig. 2.—On this south-facing slope pines are scattered over this very steep grass-covered slope; doubtless the annual burning of the grass prevents reproduction of the pines. Cervantes town is dimly visible in the far distance at the upper right. The Bontoc—Taguidin road crosses the face of the hill. Elevation about 1,400 m. (4,700 ft.). February, 1935. Ilocos Sur Province.

Some of the deep road cuts along the highest portion of the road, around 2,200 m. elevation (7,500 ft.), showed that the black organic soil was the normal soil under forest, just as on the peak of Mount Maquiling. But differing from Maquiling, on these higher mountains on the flatter spots the black soil had been buried under a meter or more of volcanic ash from some neighboring volcano. Again, in the course of centuries a new black soil had formed upon the ash deposit now solidified into a tuff; and again an eruption had occurred, burying the second black soil. And since that time, on the second layer of ash there has again been sufficient time for a black organic surface soil to have formed. The profile here thus shows two fossil soils.

The Mount Data rest house, attractively built from local materials—pine slabs with the bark on, and a thatched roof of cogon grass, is located on a sightly spot in a most magnificent grove of pines on the steep eastern slope of Mount Data. In the early morning, the valleys seen from there were filled with an intensely blue haze—wonderful in the visual effects but the despair of such an inveterate photographer as the writer.

From Mount Data, the road runs along the eastern side of the ridge, gradually dropping into the deep valley of the Rio Chico, a tributary of the Cayagan River. Higher along the ridge some few less steep spots permit of agricultural activity.

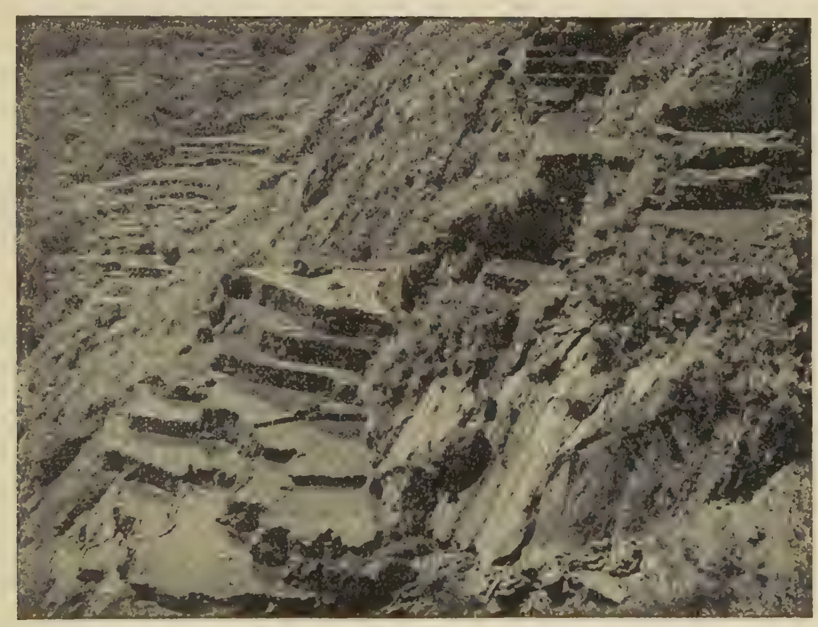
Along the slopes of the Rio Chico Valley we saw the first extensive development of terraces for the growing of irrigated rice on the steep mountain sides (fig. 3) and in the very narrow valley bottoms. The region seemed dry, for the hills were to a considerable extent deforested and the cogon already brown, but the slopes above the terraces had many springs, and the fields were well irrigated. Strongly built though the stone terrace walls are, occasionally during the heavy rains they had failed; ingenious methods were being employed to move the soil over the terraces to relevel the fields. In some cases the soil was being sluiced with running water, in others a rope was passed around a pulley on a stake at the place to which the soil was to be moved. At each end of the rope was attached a shallow wooden basin a meter in diameter. On this "pan" was placed the soil, the rope pulled by both the workers, one at the inner edge of the terrace and the other at the outside; the loaded pan was dragged out to the low spot, and the empty pan at the same time into the place where it was to be filled.

As a means of preparing the soil in the fields, prior to planting out the rice seedlings, we saw in one case a group of carabao, tied together abreast, being driven around and around in a circle; in another case the laborers themselves worked up the soil with their feet.

BETWEEN SABANGAN AND THE CHINA SEA: THE CERVANTES ROAD

At Sabangan, not far from Bontoc, we turned west toward the coast. For many kilometers to the west, except for relatively small proportion of the land on the lower slopes of the valleys which is used for irrigated rice, the country is almost one vast cogonal, scarred in many places by landslides and soil erosion.

Cervantes is a lowland type village in the Abra River Valley, a valley which, at least in this portion, has very little flat lowland. The cogon which is almost undisputed in its possession of the lower and higher hills was then, in early February, already brown, and patches of the hills were blackened where recent grass fires had swept over them. When viewed from the road high on the western mountain, the few trees in and close about Cervantes made the settlement appear as an oasis. But while there seem to be vast expanses of cogon and other grasses, only here and there broken by landslides or erosion, it is reported that there is a scarcity of suitable cogon for house thatching.



Photograph by Robert L. Pendleton

SMALL RICE TERRACES ON A VERY STEEP SLOPE IN BONTOC

Fig. 3.—Terraces for raising "lowland" rice are constructed almost anywhere in Bontoc Sub-Province if there is but a gravity supply of water from some spring or brook. The terraces in the foreground are on a steep, rocky cliff, while in the distance are some in a ravine. On the road north of Mount Data, near Sabangan. Elevation about 1,000 m. (3,500 ft.). February, 1935.

From high up on the steep ridge to the west of Cervantes (fig. 2), more and more cogon land appeared, especially down the Abra

River to the north. This region would seem to offer an enormous field for reforestation and subsequent conversion of the better portions of the land to agricultural uses. It is, of course, well known that it is impossible to directly cultivate the cogonals, but rejuvenation of the land and elimination of grass through use of ipilipil or other leguminous trees or shrubs, which at the same time can supply fuel, tan bark or oil seeds, and serve as a nurse crop for timber or oil seed trees, and renew the soil fertility for agricultural use, could with proper supervision and control pay for itself and continually expand, supporting a large agricultural and forest population.

Looking in the other direction, to some north-facing slopes on which there is hardwood growth, we saw one caiñgin which appeared almost identical in layout, fencing, and semi-terraces to retard soil erosion, with a clearing figured by Mohr in his study of the soils of Netherlands New Guinea.[7] Incidentally, some of the native Timor Island huts which are included in one of Mohr's other illustrations (fig. 47) in the same publication appear practically identical with Igorot houses.

While it may seem fanciful to consider any cultivation of these steeper hills which cannot be irrigated in any other way than by the wasteful caiñgin system, Mr. Thorp pointed out that in Puerto Rico it is very common to grow coffee on such steep slopes, even where it is so steep that to prevent the children of the coffee pickers from falling off the fields it is necessary to tie them to the coffee bushes. From time to time, as we learn of the experiences, practices, and conditions of other tropical islands, it is more and more clearly realized that our resources here are being ineffectively used and prodigally consumed, and that too often we are not making the best use of what is at hand.

Dropping down the coastal slopes of the range to the west of Cervantes, through the parang and "second growth forest", we were soon in the Ilocos country, where the struggle for existence is more intense than in any other part of Luzon. It must have been a man from Bangar town whom we passed on the road, for as he walked he was twisting cotton yarn with a distaff; it is Bangar which is reputed to have a loom for cotton cloth in every home, and where there is also a very large fish net weaving industry.

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[7] E. C. J. Mohr. De Bodem der Tropen in het Algemeen en die van Nederlandsch-Indië in het Bijzonder. Amsterdam 1934. Part II, Fig. 63.

Travelling south to Bauang, we went over the narrow coastal plain, through a country in which, in addition to rice, tobacco and some cotton are raised. There had been a vast improvement in the highway location and bridges since I had made a soil survey of the region about seven years ago. Delighted though we were with the comforts of the cottage hotel at Long Beach near Bauang, it would savor of a road guide to dwell upon them.

Before leaving La Union Province for the Zambales country we spent a little time on the rather unusual dark red and brown soils on the old, elevated coral reef which now forms the tied island or tombolo of Porro, at San Fernando. A large new fuel oil storage installation at the wharf here testified to the growth and magnitude of the Diesel power needs of the mines back in the mountains.

The Dagupan—Lingayan region is one of a succession of sandy beaches thrown up by the surf of Lingayan Gulf. Upon both the recent and the older beaches are the roads, barrios and towns, with the coconut and other trees; between the sandy ridges are the depressions; some are still rivers and esteros, others partially filled as fish ponds or salt pans, and those which have had still more sediment deposited in them are rice fields. Certainly, a detailed study of the land utilization pattern in this region would be most interesting. Though this is a densely populated region, Mr. Thorp repeatedly commented upon how much better and more prosperous and healthier the inhabitants appeared than the people in the coastal Puerto Rico country.

THE ZAMBALES REGION

Hardly more than a glimpse of the beautiful coast and bay at Sual did we have before the road to Alaminos led through the low, nearly barren hills to the west of Lingayan Gulf. But though less beautiful, this Alaminos region soon proved to be one of the most interesting regions physiographically and pedologically which we had seen in the Philippines. There seemed to be clear evidence of old peneplains and successively elevated marine terraces. Then southeast and southwest of the town there occurs a very poor sort of soil, fortunately uncommon in the Philippines—a deeply weathered, old, light reddish soil, with large quantities of iron concretions.

From Alaminos, in western Pangasinan Province, to the southern part of Zambales, there extends a relatively narrow coastal region of low hills covered for the most part by parang vegetation and poor second growth forest, with small valleys between the hills. These valleys are largely occupied by lowland rice fields, often between the fields and the beach are small mangrove swamps. In one such swamp we found the first occurrence of peat. The mountains do not seem high enough to supply much water for irrigation during the dry season, which is reported to be very long and very pronounced in this coastal region.—A region robbed of most of its forest resources, with little good land to make intensive agriculture attractive. However, there are two large valleys, one around Iba, and the other with San Marcelino and other towns; these valleys are apparently quite productive, and contrast markedly with the conditions in general. The soils in these valleys are usually gray, and at times sandy, recalling the soils of similar appearance on the eastern side of the same range, between Angeles and Tarlac.

Foresters report that Baguio pines and other unexpected trees occur at exceptionally low altitudes along the northwestern and western slopes of these Zambales mountains. These reports suggest some unusual ecological conditions which could be studied with advantage.

The steep hills south of San Antonio, and lying between Subic Bay and the China Sea are now almost entirely cogonal. Professor H. M. Curran reports that during his early forestry duty in the Philippines, when he was stationed in the Subic Bay region, he saw forests in that locality actually become so dry in the dry season that forest fires occurred; one of the very unusual cases where low elevation tropical forest has been known to burn.

Adjoining the Naval Station of Subic Bay is Olongapo, clean and well supervised—we found traffic rules more rigidly enforced in that quiet village than on some of Manila's busiest streets! Aside from the enormous floating drydock "Dewey" in the naval station there is now little of general interest. The old de-commissioned battleship *Rochester* recalls bits of naval history.

The broad and well-maintained highway from Olongapo across the Bataan Peninsula runs through some good virgin forest before reaching the caiñgins and cane lands back of Dinalupihan. But the forest is suffering from the convenient highway transportation, since the high prices for firewood in the plains to the northeast are a great inducement for firewood cutters. Large apitong and other trees of saw-log size were being cut into stove wood and hauled by motor truck out into the central plain. One cannot but hope that the private and government ipilipil plantations on Mount Arayat, already reported to be profitable, may soon be extended to a degree that will retard, if not wholly prevent, the destruction of valuable timber in the Bataan Peninsula and elsewhere around the plains.

CONCLUSION

After making such a trip, one cannot but be astonished at the enormous potentialities in soil mineral, forest, and other resources, and of the possibilities of greatly increasing the tourist traffic. While the roads are continually being extended and improved to facilitate the development along those lines, it is clear that, apart from the outstanding efforts of the Bureau of Forestry, the conservation of the natural resources of the Islands is not being effected as it should be. And one realizes how sorely are needed field studies of the soils and agriculture, and of the methods and potentialities of reforestation. The critical days are upon us, and we hardly know what our resources are, much less how to effectively use them!

ROBERT L. PENDLETON
Of the Department of Soils

The vibrant Earth is a composite. There is the lithosphere of the geologist, the hydrosphere of the oceanographer, the biosphere of the biologist, the atmosphere of the meteorologist, the ionosphere of the wireless researcher. Let these specialists get together, with the geophysicist (for our problems primarily are physical), the astronomer (for our planet is an astronomical body), and the radiologist (for it is radiant energy that bombards us), and collaborate as a Committee on Cosmical Physics. Out of such collaboration a synthesis of present knowledge might be attained, new methods of attack on stubborn problems, perhaps even some application of present unused results to the betterment of human existence, certainly the intellectual stimulus of a more articulated knowledge.

After all, the supreme research problem from the human point of view is that posed by the question of the totality of cause and effect. What are the terrestrial consequences as a whole of all these radiations, pushes, pulls, and accretions to which the planet is continually subjected? It is a large question, but even the beginning of an answer would be worth a great deal to mankind. *The Vibrant Clod* by GEORGE W. PRAY.

Harper's Monthly Magazine April, 1935.

OBSERVATIONS ON THE OCCURRENCE OF SURRA IN LAGUNA PROVINCE AND ITS RELATION TO THE 1933 OUTBREAK AMONG COLLEGE OF AGRICULTURE ANIMALS[1]

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The history of the introduction of surra into the Philippines even up to the present time is a moot question. The theory that the disease was introduced into the Islands in May, 1901, through a lot of twenty-six horses imported from Australia (Gomez, 1926) is quite remote, as the occurrence of the disease in that country has not yet been proved (Laveran and Mesnil, 1907). While Moberly (1908) claimed that it was introduced into the Philippines through an importation of race horses from India in 1901, Musgrave and Williamson (1903) stated that surra could not have existed in the Islands before May, 1901. Contrary to this version, an editorial in the *New York Medical Journal* (1902) cited Maus as having claimed that the disease, which was known as "calentura" is not wholly new, since for seasons it had been noted by Dr. Muecke, the veterinarian of the Manila Government corral at that time. From all indications, however, it is apparent that surra is an imported disease in the Philippines.

Surra has a wide distribution in the Philippine Archipelago. Nearly all provinces have been found infested with the disease. This is principally due to the presence of the ubiquitous carabao and to a lesser extent the native cattle, the main reservoirs of the causative agent plus the wide distribution of the insect vector. It occurs either sporadically or epizootically. The latter is true whenever large numbers of animals are congregated, as in the case of the army horses in the Islands, where several serious outbreaks have been recorded.

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[1] Miscellaneous contribution No. 12. Published with the permission of the Acting Dean, College of Veterinary Science, University of the Philippines. Received for publication April 10, 1935.

THE INCIDENCE OF SURRA IN LAGUNA PROVINCE

It is a well-known and accepted fact that surra is endemic around the shores of Laguna de Bay. Incidental to the work of Mitzmain (1914) on insect transmission of surra, he states: "In a study of the Government archives embracing the American veterinary report, it was ascertained that a few clearly demonstrated outbreaks of surra have occurred throughout the lake region. The military authorities have reported the necessity for abandoning certain strategic points as cavalry posts due to tremendous loss of horses from surra. In 1902, as one example, there were 113 cavalry horses destroyed in one outbreak of the disease at Santa Cruz and Pila, towns on the upper end of the lake. Less severe outbreaks have occurred since in this region among officers' mounts." Another outbreak worth mentioning was coincident with the transfer of the College of Veterinary Science, University of the Philippines to Los Baños, way back in 1919, when several horses for anatomy purposes from Manila including some horses belonging to the Department of Animal Husbandry, College of Agriculture were noted to be affected and were killed, giving no chance for the malady to spread. It is said that when the anatomy animals arrived at the college ground, they were already infected with surra.[2]

After the transfer of the College of Veterinary Science, University of the Philippines to Los Baños, Laguna in 1919, and the establishment of the veterinary clinic and hospital in November, 1920, a closer observation with regard to the epidemiology of the disease in Laguna Province was effected. Moreover, the inauguration of the regular ambulatory clinic of the college in January, 1923 afforded a further facility in its study.

Cases of surra met with in the hospital clinic. A perusal of table 1 will show thirty cases of surra met with at the veterinary hospital during a period covering almost fourteen years. Of these thirty cases, two were dogs (Yutuc, 1931), the rest all equines. These recorded cases came from Bay, Calamba, Calauan and Los Baños. One of the canine cases came from Tanauan, Batangas.

Cases of surra met with in the ambulatory clinic. Table 2 shows fifty-five cases of surra observed in the ambulatory clinic during a period covering approximately eleven years. All cases were horses except one carabao and two cattle. Ten of the equine cases herein presented have already been reported in a previous paper (Yutuc, 1934). These cases had been met with in Biñan, Cabuyao, Calauan, Los Baños, Pila, San Pablo and Santa Rosa. In other words, in practically all towns visited by the ambulatory clinic, surra was noted.

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[2] From a personal conversation with Dr. A. K. Gomez, College of Veterinary Science, University of the Philippines, Manila.

The diagnosis of all these cases reported, both ambulatory and hospital clinics, was based on microscopic finding of the causative organism. The writer entertains the idea that the incidence of surra in Laguna is higher than is actually recorded in this paper.

THE POSSIBLE ORIGIN OF THE 1933 OUTBREAK OF SURRA AMONG COLLEGE OF AGRICULTURE ANIMALS

As far as the writer could make out, Manresa (1935) is inclined to incriminate the experimental work on surra of the College of Veterinary Science, as a possible source of the outbreak, claiming that an Indian buffalo which had been treated in the college clinic during the year 1932, might have contracted surra from our experimental animals. Although this claim is not altogether impossible, it is quite improbable as the animals used for experiments were kept in a fly-proof enclosure, hence possible contagion was completely controlled. All recovered animals were paroled and even up to the present writing, these horses are still negative. Furthermore, none of the exposed horses, cattle and carabaos with which the recovered experimental cases mingled freely contracted surra so far as the writer knows. Some of these animals are still in the college clinic at Pandacan, Manila. In view of this situation, it would be surprising if the Indian buffalo got infected from our experimental animals, especially when the exposure was of comparatively short duration.[3] It may be further stated that the experiment on surra in the college was started in 1927 (Tubangui, 1930). Reference to table 1, however, shows the work on the chemotherapy of surra was started four years earlier.

In the opinion of the writer, the origin of the outbreak in 1933 came from animals in Los Baños, other than the experimental animals of the college. Reference to tables 1 and 2 will show that in 1921, two cases were recorded; 1923, one case; 1924, one case; 1926, one case; 1927, four cases; 1928, one case; and 1931, two cases. All told, twelve cases were recorded in Los Baños, during the period covered by this report. The surra cases came from Anos, Coconut

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[3] Registered as in-case in the college clinic June 14, 1932, and released 13 days later as an out-case. Thence it was taken almost daily to the clinic until October 23, 1932. Declared cured October 25, 1932.

Grove, College Junction and San Antonio, places not far from the College of Agriculture Farm. Moreover, in Bay in 1927 one case was presented to the clinic and two others in 1929. The carabaos and cattle in Los Baños are no doubt the main source of these sporadic cases in horses, observed almost yearly. The outbreak among animals of the college herd in 1933, therefore, can be attributed to the endemic nature of the disease in the locality incited probably by some obscure factors other than the introduction of Western breed of cattle and the animal improvement program of the college, particularly when the principal vector, Tabanus species abounds almost throughout the year.

In general, the nature of the disease among bubaline and taurine species is chronic of a relapsing type with tendency to recovery. Hence, it may be assumed that the college herd may have been infected at some time in the past. It might have been one or more years ago.

SUMMARY

The cited history on the introduction of surra into the Islands even up to the present time is by no means wholly accepted.

Surra has a wide distribution in the Philippine Archipelago. In Laguna Province the disease is prevalent. A total of eighty-five cases of surra were recorded during a period of fourteen years. Of these, twelve were from Los Baños.

The incrimination of the experimental animals of the College of Veterinary Science as the possible source of the 1933 outbreak among College of Agriculture animals is not established. The origin of the flare-up of the disease can be attributed to the endemic presence of surra among animals in Los Baños.

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TABLE 1

Showing surra cases presented for treatment in the hospital clinic of the College of Veterinary Science

DATE ADMITTED	KIND	LOCATION	DISPOSITION OR REMARKS
8- 8-1921	Horse	San Antonio, Los Baños	Killed 8-9, 1921.
8- 8-1921	Horse	Anos, Los Baños	Killed 8-10, 1921.
9- 5-1922	Horse	Calamba	Killed 9-16, 1922.
5- 7-1923	Horse	Coconut Grove, Los Baños	Treated and died 5-8, 1923.
7-18-1923	Horse	Pansol, Calamba	Killed, 8-19, 1923.
12- 8-1923	Horse	Calauan	Killed.
12- 8-1923	Horse	Calauan	Killed.
7- 8-1924	Horse	College Junction, Los Baños	Killed 7-8, 1924.
4- 4-1925	Horse	Calauan	Treated and died 5-3, 1925.
4- 4-1925	Horse	Calauan	Died 5-5, 1925.
4- 4-1925	Horse	Calauan	Treated and died 5-4, 1925.
4- 7-1925	Horse	Calauan	Treated and died 4-8, 1925.
5-12-1925	Horse	Calauan	Treated and died 5-19, 1925.
5-12-1925	Horse	Calauan	Treated and died 5-29, 1925.
5-15-1926	Horse	Pansol, Calamba	Treated and died.
11-13-1926	Horse	Los Baños	Treated and died.
1-14-1927	Horse	San Antonio, Los Baños	Treated and died.
2-24-1927	Horse	San Antonio, Los Baños	Treated and died.
5-30-1927	Horse	San Antonio, Los Baños	Treated and died.
8-13-1927	Horse	San Antonio, Los Baños	Treated and died.
2-25-1927	Horse	Bay	Died 3-3, 1927.
7- 1-1928	Horse	Pansol, Calamba	Treated and died 7-10, 1928.
6-28-1928	Horse	Pansol, Calamba	Treated and died 7-13, 1928.
6-13-1928	Horse	Pansol, Calamba	Treated and died 7-19, 1928.
7- 5-1929	Dog	Calauan	Treated and died 9-22, 1929.
5-27-1929	Horse	Bay	Treated and died 6-20, 1929.
5-28-1929	Horse	Bay	Treated and died 6-20, 1929.
8- 1-1930	Dog	Tanauan, Batangas	Treated and died 8-21, 1930.
8-17-1931	Horse	Anos, Los Baños	Treated and died 8-20, 1931.
1-13-1932	Horse	Calamba	Treated and died 1-16, 1932.

TABLE 2

Showing surra cases presented for treatment in the ambulatory clinic of the College of Veterinary Science

DATE REGISTERED	KIND	LOCATION	DISPOSITION OR REMARKS
6-28-1921	Horse	Santa Rosa	Killed 6-29, 1921.
6-15-1921	Horse	Cabuyao	Killed 6-15, 1921.
6-20-1921	Horse	Calamba	Killed 6-20, 1921.
9-19-1922	Cattle	San Pablo	Undetermined.
10-23-1923	Horse	Canlubang	Killed 10-23, 1923.
10-24-1923	Horse	Canlubang	Killed 10-24, 1923.
10-24-1923	Horse	Canlubang	Killed 10-24, 1923.
10-24-1923	Horse	Canlubang	Killed 10-24, 1923.
10-24-1923	Horse	Canlubang	Killed 10-24, 1923.
10-24-1923	Horse	Canlubang	Killed 10-24, 1923.
10-24-1923	Horse	Canlubang	Killed 10-24, 1923.
7- 3-1924	Horse	Cabuyao	Recommended to be killed.
8- 6-1924	Horse	Cabuyao	Recommended to be killed.
8-12-1924	Horse	Calamba	Recommended to be killed.
8-12-1924	Horse	Calamba	Recommended to be killed.
8-12-1924	Horse	Calamba	Recommended to be killed.
8-20-1924	Horse	Cabuyao	Recommended to be killed.
9-24-1924	Horse	Cabuyao	Recommended to be killed.
9-27-1924	Horse	Santa Rosa	Recommended to be killed.
9-27-1924	Horse	Santa Rosa	Recommended to be killed.
10- 1-1924	Horse	Cabuyao	Recommended to be killed.
10- 3-1924	Horse	Biñan	Recommended to be killed.
10-11-1924	Horse	Santa Rosa	Recommended to be killed.
10-22-1924	Horse	Santa Rosa	Recommended to be killed.
10-29-1924	Horse	Cabuyao	Recommended to be killed.
12-12-1924	Horse	Santa Rosa	Recommended to be killed.
12-12-1924	Horse	Santa Rosa	Recommended to be killed.
9- 2-1925	Horse	Santa Rosa	Recommended to be killed.
9- 9-1925	Horse	Santa Rosa	Recommended to be killed.
9-11-1925	Horse	Biñan	Recommended to be killed.
9-16-1925	Horse	Santa Rosa	Recommended to be killed.
9-16-1925	Horse	Santa Rosa	Recommended to be killed.
12- 7-1927	Horse	Santa Rosa	Recommended to be killed.
1-11-1927	Horse	Santa Rosa	Recommended to be killed.
7- 2-1928	Horse	Los Baños	Recommended to be killed.
8- 4-1930	Horse	Pila	Recommended to be killed.
8-14-1930	Horse	Pila	Recommended to be killed.
8-17-1931	Horse	Anos, Los Baños	Died after treatment was given.
8-24-1931	Horse	Calamba	Recommended to be killed.
10-23-1931	Horse	Calamba	Died several days after treatment.
8-28-1931	Carabao	Calamba	Reported died after a week.
11-16-1931	Cattle	Biñan	Undetermined.
7-18-1932	Horse	Calamba	Treated; animal recovered and still alive.
11-16-1932	Horse	Santa Rosa	Did not survive the course of treatment given; animal died.
7-29-1932	Horse	Calamba	Died 7-29, 1932. No treatment given.
8-26-1932	Horse	Pansol, Calamba	Owing to advanced condition, animal did not survive treatment; died.
7-16-1932	Horse	Calamba	No relapse, condition good. Because of severe contracted tendons, killed after 11 months.
7-29-1932	Horse	Calamba	Treated; animal recovered and still alive.
9-21-1932	Horse	Santa Rosa	Treated; condition excellent, animal still alive.
9-29-1932	Horse	Santa Rosa	Died during course of treatment.
2- 1-1933	Horse	Santa Rosa	Reported dead, 153 days after treatment.
2-13-1933	Horse	Biñan	Treated, recovered and still alive.
2-14-1933	Horse	Biñan	Treated, recovered and still alive.
2-20-1933	Horse	Biñan	Owing to advanced condition, animal not treated.
9-25-1933	Horse	Biñan	Died 62 days after treatment.

STUDIES ON SURRA: III. A SURVEY OF THE INCIDENCE OF SURRA IN THE VICINITY OF THE COLLEGE OF AGRICULTURE WITH OBSERVATIONS ON NUMERICAL FLUCTUATIONS OF TABANID FLIES[1]

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Of the Department of Animal Husbandry

WITH ONE MAP

THE SURVEY

The outbreak of surra in 1933 among animals belonging to the College of Agriculture was characterized by the suddenness of its appearance, and the relatively large number of animals affected. In attempting to control the spread of the infection, heroic measures were taken which would have been unavailing if animals outside of the College Campus were acting as reservoirs of the infection. In November, 1934, therefore, and for a period of about five months thereafter the junior author conducted an investigation in the barrios of San Antonio, Batong Malaki, Maahas, Bayog, Mayundon, Anos, Bambang, Tadlac, Lalakay, Poblacion of Los Baños, and the barrio of Puthô of the municipality of Bay, Laguna (see map) for the purpose of determining the extent and seriousness of surra in these localities.

In the beginning, a systematic house to house canvass was conducted, during which the animals were examined in the corral or at some convenient place near the owner's residence. Finding this method impractical, as often either the owner, from whom consent was necessary, or the animal, or both were not present, a random examination was resorted to, in the subsequent blood tests. The animals were sought in the rice and sugar cane fields, preferably where harvesting was in progress. Blood smears were taken from any animal found, whether it was for the first, second, third or fourth time.

The test used in this connection was the microscopical examination of the animal's blood. In oxen and carabaos, the blood was

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[1] Experiment Station contribution No. 1032. Received for publication April 11, 1935.

drawn from any visible vein on the dorsal surface of either ear. In horses it was drawn from the tip of the ear by pricking with a needle after the hair had been clipped off with a pair of scissors. In both operations disinfectants were used freely. In some cases dry smears were made, fixed and dehydrated in ethyl alcohol and stained with Giemsa.

DISTRIBUTION OF ANIMALS IN THE MUNICIPALITY OF LOS BAÑOS IN 1933

The following tabulation shows the number and distribution of animals in the different barrios of the municipality of Los Baños in 1933:[a]

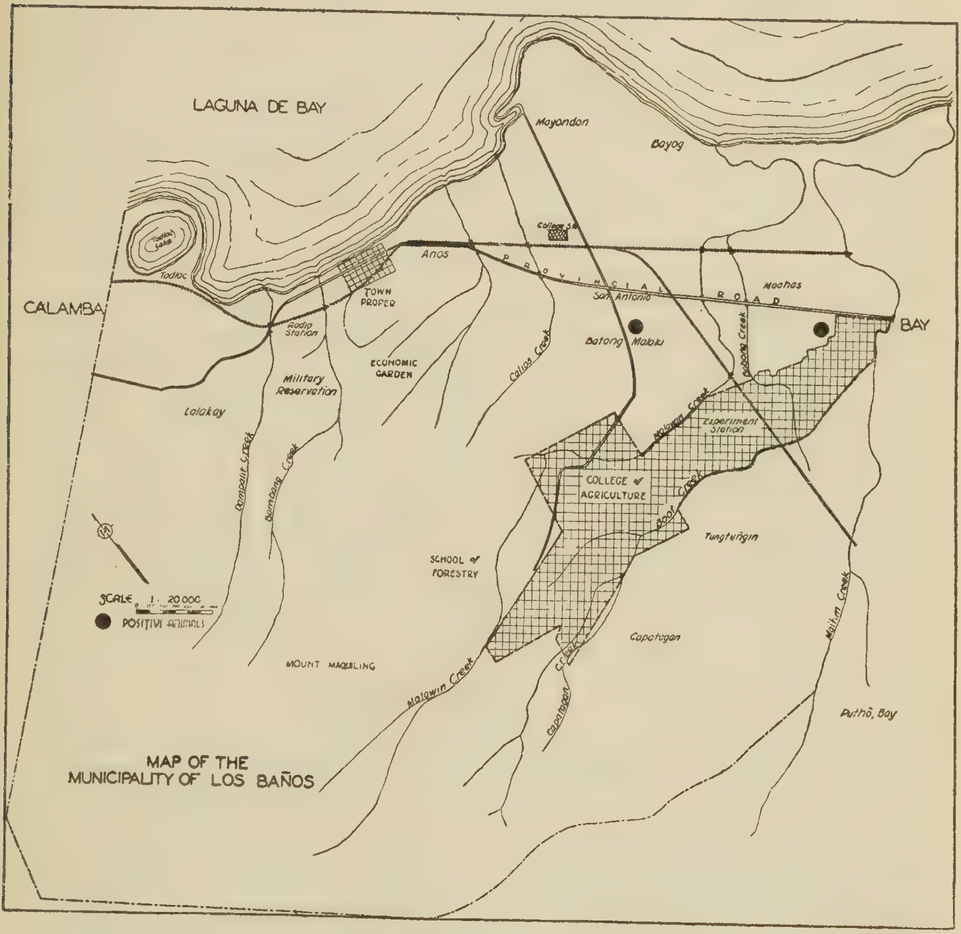
BARRIOS	CARABAOS	CATTLE	HORSES	TOTAL
Población	49	55	30	134
Bambang	12	15	10	37
Lalakay	36	58	8	102
Tadlac	35	5	1	41
Anos	121	88	31	240
Maahas	84	36	26	146
Bayog	75	23	—	98
Mayundon	107	20	9	136
San Antonio	80	25	43	148
Batong Malaki	55	23	39	117
Totals	654	348	197	1199

[a] Courtesy of the Municipal Treasurer, Los Baños, Laguna.

It will be seen from the foregoing tabulation that the animal population of the municipality of Los Baños for the year 1933 was 197 horses, 348 cattle and 654 carabaos or a total of 1199 animals. Of these animals, 94 horses representing 47 per cent of the horse population, 117 cattle representing 36 per cent of the cattle and 283 carabaos representing 28 per cent of the carabaos were examined. Of the total number of horses examined, 52 were tested two times, 14, three times and 9, four times. Among oxen, 69 were examined two times, 20, three times and 3, four times. In carabaos, 93 were examined two times, 32, three times and 21, four times.

Table 1 shows the number of animals and the number of times they were examined. It will be noted that the largest number of animals examined were in the barrios of San Antonio, Puthô and Maahas. There were many animals in these barrios and in San Antonio and Maahas many repeated blood examinations were conducted. Consequently, new animals were included from time to time in the subsequent blood tests.

The first case of trypanosomiasis was detected on January 9, 1935, in a carabao belonging to Nicolas Katimbang, a resident in San Antonio. Only one organism was seen in the entire field of the slide. To confirm this finding the same animal was again examined one day later. No trypanosomes could be detected even after six slides had been examined. However, on January 12, this particular carabao exhibited the organism again in the peripheral circulation. Several trypanosomes were seen in both the fresh and in the stained slides.


LAGUNA DE BAY
Mayondon
Bayog
Tadlac Lake
Tadlac
College St.
Anos
PROVINCIAL ROAD
San Antonio
Maahas
CALAMBA
TOWN PROPER
Radio Station
Batong Malaki
BAY
ECONOMIC GARDEN
Calios Creek
Bobong Creek
Malawin Creek
Military Reservation
Experiment Station
Lalakay
COLLEGE of AGRICULTURE
Dampalit Creek
Bambang Creek
Boot Creek
Tungtungin
SCHOOL of FORESTRY
SCALE 1 : 20000
● POSITIVE ANIMALS
Capatagan
Maitim Creek
MOUNT MAQUILING
Malawin Creek
Capatagan Creek
Putho, Bay
MAP OF THE MUNICIPALITY OF LOS BAÑOS

Inquiries from the owner revealed that this carabao had been frequently pastured in the fields of Maahas, having been allowed to wallow in the stream which borders the Experiment Station of the

College of Agriculture, where a number of surra cases had been found. Doctor Villegas and Mr. Esguerra were able to get the owner's consent to place the infected carabao in the Isolation Barn of the Department of Animal Husbandry. This was done on February 27, 1935. The suggestion was made by Dean Gonzalez so as to preclude the possibility of the animal spreading infection.

The second case of the disease, also in a carabao, was found on January 18, 1935. Unfortunately, the identity of the animal was not known, as the blood was taken in the absence of the owner. It was one of a group of twenty carabaos found grazing in a rice field of Maahas. They were tied and grouped together, a condition very ideal for taking blood samples. This opportunity could not be resisted. Repeated re-examination of the carabaos grazing in the same field failed to locate the infected animal. It is possible that this was the same carabao owned by Nicolas Katimbang.

The sketch map of the municipality of Los Baños shows that Maahas and San Antonio are in the immediate vicinity of the College. None of the 98 carabaos examined in the barrio of Puthô exhibited trypanosomes. This barrío borders the Tungtuñgin and Almira pastures of the Animal Husbandry Department. There are many animals in this barrio but they probably do not constitute a menace to the animals inside of the College Campus. Likewise, no case of trypanosomiasis was found in the barrios of Mayundon, Anos, Bayog, Los Baños Poblacion, Bambang, Tadlac and Lalakay. These barrios surround the College grounds but are relatively distant.

PREVALENCE OF TABANID FLIES

Practically every blood sucking parasite of horses, oxen and water buffaloes has been found by one investigator or another to be an agent in the transmission of trypanosomes (Mitzmain, 1913; Kelser, 1927; Bubberman, 1930, etc.), but the tabanid species have been regarded by most investigators as the most dangerous. These flies have been found on the Campus and it was thought essential to get definite data on the degree of abundance and habits of these flies in connection with the study of the epidemicity of surra. The first attempt consisted in determining the time of the day when the flies were most numerous. Observations made by the senior author in the month of January, 1934, from as early as possible before sunrise and continuously to as late as after dusk, indicated that the time when the tabanid flies were most numerous was from about five o'clock in the afternoon to dusk, the flies gradually disappearing as darkness came on. Their presence could be discerned by the characteristic buzzing sound they made during flight.

This observation was verified repeatedly later in studies made both on the College Campus and outside. Table 2 shows the average number of tabanid flies actually caught by one man at hourly intervals from two carabaos placed in open pastures in the Department of Animal Husbandry. It may be seen that there was not a great deal of difference between the average number of flies caught from six to twelve o'clock in the morning and the number caught in the afternoon from one to five o'clock. But the number caught from five o'clock to dusk was invariably the largest. The data shown in the table were secured during February and March, 1934. The observations were repeated in December, 1934 and in February, 1935, with quite identical results.

In view of the foregoing data in the regular daily observations on the prevalence of *Tabanus striatus* Fabricius carried out in the Department of Animal Husbandry for a period of 13 months, the catches were made within about one hour before dusk. A tame animal, either an ox or a carabao, was placed in different fields and the flies alighting on the animal were caught. During the first few months all the catches were taken to the Department of Entomology for identification. Dr. L. B. Uichanco, Head of this department, stated that all the specimens sent to him belong to the species *striatus* and that they were all females.

Table 3 shows the average number of tabanid flies actually caught in the different months from February, 1934 to March, 1935. These monthly averages varied from 3.00 to 42.0, the general average during the whole period of observation of 13 months being 13.4 flies. Our daily record shows that as many as 79 flies were caught by one man from one animal in the course of about one hour. One of the students assigned to do this work, Mr. Segundino Barraquero was able to dispense with the use of fly traps, catching the flies with either hand. The flies were most abundant when the weather was calm and bright. Strong winds with afternoon showers seemed to be inimical to their appearance, but some tabanid were caught alighting on the animals even during stormy afternoons.

Table 4 gives a fair sample of the catches at daily intervals in January and February, 1935. The data shown in the table are important from the point of view of the epidemicity of surra as related to the incidence of tabanidae. It did not seem that there were fewer flies in the months of January and February in 1935 than in the corresponding months of the year previous. In November, 1934 and for a period of 64 days thereafter, the junior author studied the frequency of tabanid flies in (*a*) oxen in the open field, (*b*) horses in the open, and (*c*) oxen under shelter. A horse and an ox were tied close together in the open field at a distance of about five meters from another ox which was put in a shed. The shed was low, and roofed with nipa, but without walls. This is the type of stall commonly used in the barrios under investigation. The tabanid flies alighting on these animals were caught during a period of about 20 minutes before dusk.

From the data shown in table 5, it may be seen that on the ox kept under shelter the average number of tabanids caught was 0.33, while the average number caught on the ox kept in the open field was 6.02. It was also found that fewer flies alighted on the horse than on the ox when both horse and ox were in the open field. Interrupted observations for a period of 15 days beginning on February 18, 1935 were made on a horse belonging to the Department of Animal Husbandry, kept in a stall. No tabanids were caught. During the same period 34 tabanid flies were caught from a carabao (Indian buffalo) calf which was placed in a run adjoining the stall.

GENERAL DISCUSSION OF RESULTS

The statement is frequently made that surra is widespread over the Philippines and that the carabaos and cattle are perennial reservoirs of the infection.[2] This statement needs clarification. Undoubtedly, it is the deduction made from scattered reports of field men and from the work of Kelser (1927) who in adopting the method of complement-fixation test for surra subjected 141 carabaos and 54 oxen to the test. The animals were picked out from lots of work animals bought in different parts of Luzon to be immunized against rinderpest, and the tests were made immediately after the arrival of the animals at Pandacan, Manila.

In the two localities we have surveyed; namely, the College of Agriculture pastures and fields, that is, the area inside of the College including the Experiment Station ground and the area outside of these fields, we have found the intensity of the surra infection to be very dissimilar. Hence, it can not be said that every locality in Luzon is infected in a uniform way. It appears, therefore, that before making any general statement regarding the prevalence of the disease over a wide territory, a thorough and comprehensive survey will have to be made.

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[2] Report of the Philippine Veterinary Medical Association Committee on Diseases. Bureau of Animal Industry Gazette. Vol. 3, No. 2. February, 1933.

During the early part of the outbreak of surra in 1933 in the College of Agriculture, it was reported (Manresa, 1935) that from a total of 193 microscopical blood examinations in 119 oxen, 64 water buffaloes, and 10 horses inside of the College of Agriculture and Experiment Station fields, 19 cases were found positive for surra, constituting 10.15 per cent. In the survey reported in the present paper, the data show that from a total of 807 microscopical blood examinations in carabaos, oxen and horses located outside of the College of Agriculture and Experiment Station fields only two cases or less than one-fifth of one per cent were found positive for the disease. That the intensity of the infection inside of the College was decidedly much higher than it was outside is evident. As the spread of the infection, like the spread of wild fire, does not ordinarily proceed from foci of low intensity to high but the reverse, it is not likely that the immediate source of the outbreak of surra in 1933 in the College of Agriculture could have originated from without as claimed by Yutuc (1935).

Nor is the claim tenable or even the suspicion that surra is enzootic in the College of Agriculture. There had not been a single case of the disease in the Department of Animal Husbandry from 1919 to 1933, or a period of fourteen years (Manresa, 1934). Moreover, all the animals from the College of Agriculture that were exhibited in the Live Stock Exposition of the Philippines Carnival held in Manila in February, 1933, were tested for surra thoroughly by the Bureau of Animal Industry, and no trypanosomes were found in any of them. All the College purebred Hereford cattle were shown in that Exposition. However, in December, 1933, that is, after a lapse of less than ten months, upon making a survey of the surra infection in our College herds, it was found that not only was the herd consisting of pure breeds and high grade Herefords heavily infected, but all the pure breeds disclosed the trypanosomes. (THE PHILIPPINE AGRICULTURIST, vol. 23, p. 755, 1935).

It can not be argued that insect vectors had been wanting. The data presented in the present report on the numerical fluctuations of tabanid flies, acknowledged as the most important factor in the dissemination of surra, show that the flies are present in large numbers the whole year round. A drastic revision of the present accepted views on the epidemicity of surra will have to be made should it be proved that *Trypanosoma evansi* can remain uninfective for a period of fourteen years, not touching even a single horse from a number that had been constantly exposed during all that period. Moreover, the tabanid fly is not the only factor in the transmission of surra. Even the mosquitoes (*Aedes aegypti*) have been found to transmit the disease in interrupted feeding. (Kelser, 1927), and Topacio (1934) demonstrated that inoculations of single surra trypanosome produced infection and death in susceptible animals.

The foregoing data, in addition to those already presented in a previous paper on the subject (Manresa, 1935), make it fairly conclusive that the immediate source of the surra outbreak in 1933 in the College of Agriculture must have been from within the College Campus, including the portion formerly designated as the College of Veterinary Science Campus and shortly before the disease was observed in the animals belonging to the Department of Animal Husbandry in December, 1933. Doctor Yutuc (1935) candidly admits that the horses brought in by the College of Veterinary Science from Manila in 1919[3] to be used by Veterinary anatomy classes in the College of Veterinary Science were surra infected prior to their arrival at Los Baños, thus making the source of the surra outbreak in 1919 in the College of Agriculture directly traceable to them. It may not be too much to expect that a similar refreshing admission will be made later on in regard to the recent outbreak of the disease in 1933.

The problem that present investigators on surra should try to solve is the existence of so great a disharmony between certain unproved beliefs regarding the disease and the regular upward trend of the animal population, including horses, in countries where surra is said to be enzootic. In the Philippine Islands, for example, during the stretch of 22 years, that is, from 1910 to 1932, the horses and carabaos more than trebled in number while the oxen more than sextupled. In British India, likewise, oxen and water buffaloes increased fairly regularly from 145,103,000 in the year 1921 to 154,629,000 in 1931 (U. S. D. A. Yearbooks, 1924-1934). Largely on the basis of our experiments (Manresa and Gonzalez, 1935) it has been possible to advance a working hypothesis which, if followed to its logical conclusions, may help to answer this puzzling question, eventually. However, other modes of attack should be attempted, for it seems that the problem is a complex one.

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[3] The first and second year classes of the College of Veterinary Science were conducted in Los Baños beginning 1919 conforming to the resolution passed by the Board of Regents transferring the College of Veterinary Science from Manila to Los Baños, "believing that the College would give greater benefit to the country by operating it side by side with the College of Agriculture."—G. SAN AGUSTIN (1929). The College of Veterinary Science. THE PHILIPPINE AGRICULTURIST, 18 (5):270.

We have found that under identical conditions horses were less frequently visited by tabanid flies than oxen (see table 5). It was also shown that an animal placed under shelter was less frequently visited by tabanids than another kept in the open field. As most horses in the barrios investigated are kept under shelter when not in use the tabanid flies must have had even more restricted access to them. Inasmuch as only a small proportion of the animals examined was found to harbor the infective organism the chances of disease transmission through these vectors may have been rendered practically nil. Then, again, it may be that even the horses may have other means, biological or otherwise, of protecting themselves from the infection.

When the whole field of surra has been thoroughly explored from all angles, it may likely be that the explanation of this puzzle is a simple one. Our experiments on the subject are based on the general hypothesis that natural selection is in continuous operation and this, we believe, has been largely responsible for the present state of condition in surra. With such a working hypothesis some further work on the subject can be pursued.

SUMMARY AND CONCLUSIONS

1. No case of trypanosomiasis was found in the vicinity of the College of Agriculture in 94 horses examined, 52 of which were tested two times, 14, three times and 9, four times. No case of trypanosomiasis was found in 117 oxen examined of which 69 were tested two times, 20, three times and 3, four times. Only one definitely positive surra case was found in 283 carabaos examined, 93 of which were tested two times, 32, three times and 21, four times.

2. The *Tabanus striatus* Fabricius was found to be present throughout the whole period of observation, being most prevalent during the hour before dusk, less so between six o'clock in the morning and about five o'clock in the afternoon. Horses were less frequently visited by tabanids than oxen, and animals kept under shelter were less frequently visited than those kept in the open fields.

3. The intensity of surra outside of the College grounds and fields was very much lighter than it was inside of these fields. This, together with other data, make the evidence conclusive in showing

that the immediate source of the outbreak of surra in 1933 in the College of Agriculture originated from within and shortly before the disease was observed in the animals of the Department of Animal Husbandry.

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TABLE 1

Showing by barrios the number of animals and the number of times they were examined

BARRIOS	CARABAOS				CATTLE				HORSES				TOTAL
	Number of times examined				Number of times examined				Number of times examined				
	1	2	3	4	1	2	3	4	1	2	3	4	
Anos	16	6	—	—	19	12	—	—	11	—	—	—	
Bambang	2	—	—	—	9	3	—	—	9	6	—	—	
Batong Malaki	14	5	—	—	9	3	—	—	13	5	—	—	
Bayog	16	6	—	—	12	8	—	—	2	—	—	—	
Lalakay	3	—	—	—	2	—	—	—	2	—	—	—	
Los Baños (poblacion)	11	2	—	—	21	11	—	—	9	7	—	—	
Maahas	35	31	17	9	20	12	10	1	7	3	—	—	
Mayundon	18	10	—	—	5	2	—	—	—	—	—	—	
San Antonio	61	33	15	12	20	18	10	2	41	31	14	9	
Tadlac	9	—	—	—	—	—	—	—	—	—	—	—	
Putho, Bay	98	—	—	—	—	—	—	—	—	—	—	—	
Total	283	93	32	21	117	69	20	3	94	52	14	9	807

TABLE 2

Showing the average number of tabanid flies actually caught at hourly intervals from two carabaos placed in open pastures of the Department of Animal Husbandry, College of Agriculture

DATE	MORNING						AFTERNOON				
	6-7	7-8	8-9	9-10	10-11	11-12	1-2	2-3	3-4	4-5	5 to dusk
1934											
February											
12–14	1.0					3.3					24
23–25		0.3					4.6				43
26–28			3.0					5.0			24
March											
1–3				1.0					0.3		16
4–6					0.5					0.3	19

TABLE 3

Showing the average number of tabanid flies actually caught from one animal within about one hour before dusk from February, 1934 to March, 1935 (Department of Animal Husbandry)

MONTHS	NUMBER OF DAYS	NUMBER OF FLIES CAUGHT	AV. FOR THE MONTH	REMARKS
1934				
February	23	236	10.3	
March	24	440	18.3	
April	13	225	17.3	
May	5	210	42.0	
June	—	—	—	
July	13	87	6.7	
August	23	236	10.3	
September	6	46	7.7	Strong winds with afternoon showers were frequent.
October	9	27	3.0	Frequent typhoons or strong winds with afternoon showers.
November	24	155	6.5	
December	19	66	3.5	
1935				
January	24	403	16.8	
February	18	499	27.7	
March	22	346	15.7	
Total	223	2976	13.4	

TABLE 4

Showing the daily observations in the College of Agriculture on the incidence of tabanid flies on oxen from January 9 to February 18, 1935

DATE	PLACE OF OBSERVATION	NUMBER OF FLIES		WEATHER CONDITIONS
		Caught	Seen, but not caught	
1935				
Jan. 9	Pinagtulusan 1	8	3	Strong breeze.
10	Exper. Sta. Br.	10	0	Good weather (carabao used)
11	Poultry yards	4	0	Good weather
12	Exper. Sta. Br.	26	0	Good weather
14	Poultry yards	30	0	Good weather
15	Poultry yards	23	0	Good weather
16	Poultry yards	14	0	Cloudy and calm
17	Poultry yards	32	0	Cloudy and calm
18	Poultry yards	37	0	Good weather
19	Poultry yards	16	0	Good weather
21	Poultry yards	15	0	Good weather
23	Pinagtulusan 1	11	1	Cloudy and windy
24	Pinagtulusan 1	13	0	Cloudy and windy
25	Pinagtulusan 1	37	0	Cloudy and windy
26	Pinagtulusan 1	22	0	Good weather
28	Forage Lot	43	0	Good weather
30	Forage Lot	17	0	Good weather
31	Tanza pastures	23	3	Good weather
Feb. 1	Forage lot	12	0	Good weather
2	Forage lot	17	2	Good weather
4	Forage lot	40	5	Good weather
5	Forage lot	48	2	Good weather
6	Forage lot	27	0	Good weather
7	Forage lot	52	0	Good weather
8	Forage lot	45	0	Good weather
9	Forage lot	28	0	Good weather
11	Forage lot	26	0	Good weather
12	Forage lot	9	0	Strong breeze
13	Forage lot	23	0	Slight breeze
15	Forage lot	32	0	Good weather
16	Forage lot	26	0	Good weather
18	Range	28	0	Good weather (three animals)

TABLE 5

Showing observations in San Antonio, Los Baños on the incidence of tabanid flies on horses and oxen in the open and oxen under shelter

DATE	IN THE OPEN		UNDER SHELTER	WEATHER CONDITIONS
	Horses	Oxen	Oxen	
1934				
Nov. 1	0	2	0	Clear and windy.
2	1	3	0	Clear and slightly windy.
3	1	2	0	Cloudy and calm.
4	2	4	1	Cloudy and calm.
5	1	2	0	Cloudy and calm.
6	3	4	1	Clear and calm.
7	2	6	0	Clear and calm.
8	0	1	0	Clear and slightly windy.
9	1	6	0	Clear and calm.
10	0	3	0	Clear and calm.
11	1	3	0	Clear and calm.
12	0	6	0	Clear and slightly windy.
13	1	3	1	Slight shower & slightly windy.
14	0	0	0	Cloudy and calm.
15	—	—	—	Stormy.
16	—	—	—	Stormy.
17	0	3	0	Clear and windy.
18	2	2	0	Clear and windy.
19	2	2	1	Clear and slightly windy.
20	0	1	0	Clear and slightly windy.
21	0	1	1	Showering and calm.
22	0	11	0	Cloudy and slightly windy.
23	2	2	0	Showering and calm.
24	0	3	0	Cloudy and calm.
25	1	3	0	Clear and slightly windy.
26	1	2	1	Clear and calm.
27	3	7	1	Clear and calm.
28	—	—	—	
29	—	—	—	
30	—	—	—	
1934				
Dec. 1	1	6	0	Clear and slightly windy.
2	3	4	1	Cloudy and calm.
3	0	10	0	Cloudy and calm.
4	1	5	1	Cloudy and calm.
5	2	2	0	Cloudy and slightly windy.
6	3	2	0	Cloudy and windy.
7	0	14	0	Cloudy and calm.
8	0	6	0	Clear and windy.
9	1	6	0	Cloudy and calm.
10	0	5	0	Cloudy and calm.

TABLE 5—(Continued)

DATE	IN THE OPEN		UNDER SHELTER	WEATHER CONDITIONS
	Horses	Oxen	Oxen	
11	1	7	0	Cloudy and slightly windy.
12	0	4	1	Clear and slightly windy.
13	—	—	—	Cloudy and slightly windy.
14	0	2	0	Showering and slightly windy.
15	2	3	0	Cloudy and calm.
16	—	—	—	Cloudy and calm.
17	1	3	1	Showering and calm.
18	1	6	0	Cloudy and calm.
19	2	2	0	Clear and calm.
20	0	12	0	Cloudy and calm.
21	—	—	—	Cloudy and slightly windy.
22	2	0	0	Slightly cloudy and calm.
23	1	5	0	Slightly cloudy and calm.
24	0	8	0	Slightly cloudy and calm.
25	2	4	0	Showering and calm.
26	3	6	1	Clear and calm.
27	4	6	0	Clear and calm.
28	—	—	—	Clear and slightly windy.
29	10	12	1	Clear and slightly windy.
30	—	—	—	
31	—	—	—	
1935				
Jan. 1	—	—	—	Cloudy and slightly windy.
2	2	7	0	Cloudy and slightly windy.
3	2	5	2	Clear and calm.
4	0	8	0	Clear and calm.
5	—	—	—	Slightly cloudy and windy.
6	2	11	0	Clear and slightly windy.
7	0	7	0	Cloudy and slightly windy.
8	2	6	1	Clear and windy.
9	1	9	0	Clear and windy.
10	3	8	0	Cloudy and windy.
11	7	12	0	Cloudy and slightly windy.
12	3	8	3	Cloudy and slightly windy.
13	3	13	0	Cloudy and slightly windy.
14	5	19	0	Clear and calm.
15	2	15	2	Clear and calm.
16	1	15	0	Cloudy and calm.
Average ...	1.36	6.02	0.33	

THE RED ROT OF SUGAR CANE CAUSED BY COLLETOTRICHUM FALCATUM WENT[1]

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WITH TWO TEXT FIGURES

Red rot is a fungous disease of sugar cane (*Saccharum officinarum* Linn.) caused by *Colletotrichum falcatum* Went. The disease is rather common in the Philippine Islands although usually it is not serious.

Not much is known about red rot although the disease was first reported in the Philippines by Reinking in 1919. Earle (1928) reports that *Colletotrichum falcatum* occurs in the Philippines only as a leaf parasite causing long red patches on the upper surface of the midribs.

While working as Cane Yard Inspector at the Calamba Sugar Estate, Canlubang, Laguna in 1931, the junior author found that red rot was frequently present in the canes which came from Batangas, Laguna and Cavite provinces. The canes from these three provinces showed a low percentage of sucrose. The disease is also prevalent in the Experiment Station of the College of Agriculture at Los Baños and in the immediate vicinity.

THE DISEASE

Red rot appears to be confined to sugar cane and sorghum (*Andropogon sorghum* [L.] Brot.) and its causal fungus is *Colletotrichum falcatum* Went. Butler (1906) used the name "red rot" in describing the disease. Tryon (1901), Butler (1906), Lewton-Brain (1908), Edgerton (1910), Fawcett (1910), Burger (1922), Johnston and Stevenson (1917), Wood (1927), Quintus (1923), Earle (1928), and many others call the disease red rot.

Lewton-Brain (1908) states that the disease was observed for the first time during the grinding season of 1892 in Java.

In regard to its geographical distribution the red-rot disease of sugar cane is now known in Cuba, Brazil, Peru, United States, Java, Porto Rico, Hawaii, Southern China, Australia, India, South America, Mexico, British West Indies, the Fiji Islands, Mauritius, the Philippine Islands and perhaps in other sugar producing countries.

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[1] A portion of a thesis presented by the junior author for graduation, 1933, with the degree of Bachelor of Agriculture from the College of Agriculture No. 452; Experiment Station contribution No. 1034. Prepared in the Department of Plant Pathology under the direction of and revised by the senior author. Received for publication October 31, 1934.

It may thus be seen that the disease has a world-wide distribution, occurring in nearly every region where sugar cane is grown.

Economic importance

Butler (1906) states that red rot is one of the most serious diseases of sugar cane in India. The presence of the fungus in any portion of the cane is sufficient to impoverish the whole stalk and render it unfit for sugar making. Edgerton (1911) states that the losses from red rot disease consist of (*a*) loss in stand, (*b*) killing of the young plants, (*c*) injury to the leaves, and (*d*) loss in percentage of sucrose with a corresponding increase in glucose.

In the present work, the loss in stand of canes infected with red rot could not be accurately determined because pineapple disease caused by *Ceratostomella paradoxa* Dade was frequently associated with red rot infection. In Louisiana, Edgerton and Moreland (1920) found that the red-rot fungus, *C. falcatum* is very common in seed-cane pieces, causing deterioration. Abbott (1931) reports that red rot is a factor in the planting program in Louisiana. The writers found that the disease is not serious on young plants in the College of Agriculture. In Los Baños and Canlubang, Laguna, however, a definite injury is caused by the fungus on the cane leaves.

The disease does not affect very much the tonnage production but it is reported as reducing materially the sucrose content of the cane juice.

Analyses made of the sucrose content of canes with red-rot disease and of healthy canes showed a loss of 31 per cent of the sucrose as a result of the fungous invasion. Samples taken from canes shipped from Bayabasan, Cavite, to Calamba Sugar Estate showed that these canes were severely infected with red rot. In these canes the analyses show that the healthy canes had a purity of 92.5 per cent. When the juice, having 55.1 purity, of the canes infected with red rot was mixed with the juice of healthy canes, the purity of the mixed juices was considerably lowered, which perhaps explains the low purity of the crusher juice obtained. These results tend to show that in the Philippines the disease is of some economic importance. The sucrose-reducing effect of red rot was demonstrated by Lewton-Brain (1908). This author grew the fungus in culture media con-

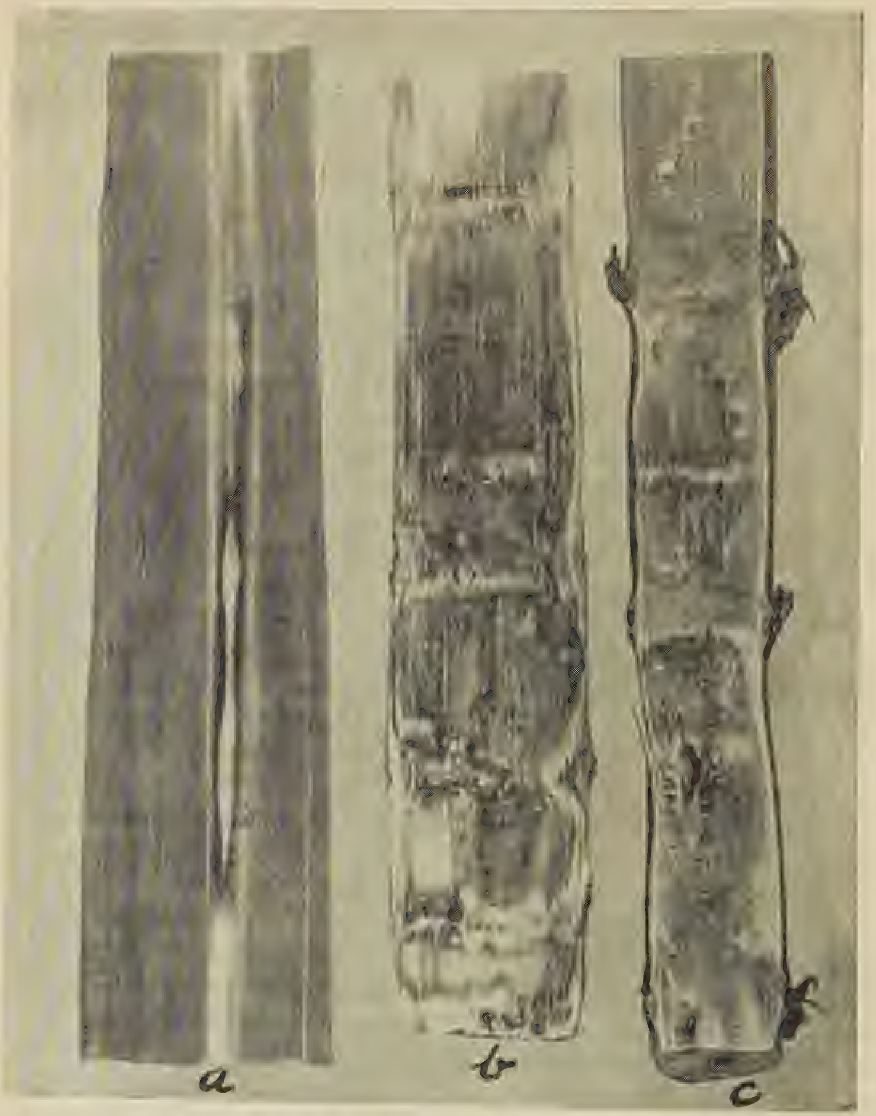

Fig. 1.—*a*. Portion of the leaf of sugar cane showing elongated spot on the midrib caused by red rot infection. *b*. and *c*. Portion of the split stem of sugar cane showing red rot infection in the internal tissue. Note the white streaks traversing the discolored region of the diseased tissue. (Photograph by Photographic Division, Department of Soils.)

taining sugar. After the analyses were made of the inoculated sugar media a gradual decrease of the sucrose in the solution accompanied by an increase of the glucose content was noted. The decrease in sucrose was attributed to the inverting enzyme secreted by the fungus.

Symptoms

The appearance of red rot on sugar cane has been described in detail by various investigators.

A brief description of the disease as noted on canes at the College of Agriculture at Los Baños is here given.

On the stem. In early stages of infection no external symptoms of the disease on the canes are visible. Hence it is difficult to recognize the disease in the field. But on splitting the stalk of an infected cane a red color of the storage tissue is at once noted and an odor of fermentation is generally given off. White areas running horizontally through the bright red tissue in the internode may be seen (fig. 1b). The presence of these streaks serves to identify the disease with certainty. As the disease advances, the leaves gradually wither. In the final stages (fig. 1c) the pith forms a cavity containing a dense mass of mycelium which is dull mud in color.

On the leaves. On the midrib, the disease first appears as a small red spot. The spot increases in size rapidly and elongates in a direction parallel with the axis of the midrib.

In the later stages of infection the center of the bright red color fades to a straw color. Minute black fruiting bodies may develop (fig. 1a) on the straw-colored tissue. Edgerton (1911) states that the disease of the stem may be indicated by the presence of the fungus on the leaves. The writers, however, did not find instances where infection of the leaf indicated consistently the presence of the fungus in the stalk.

On the roots. In this work the cause of the rotting of the root could not be definitely attributed to red rot infection.

THE CAUSAL ORGANISM

Lewton-Brain (1908) gives a translation of Went's original Latin description as follows: "*Collectotrichum falcatum*, setae sometimes in rows, sometimes united into pseudo-conceptacle, sharply pointed, 100 to 200 by 4 micro-millimeters, dark colored, lighter above. Conidia falcate and hyaline 25 by 4 micro-millimeters. Basidia ovoid, 20 by 8 micro-millimeters, hyaline or dark. Habitat in living stems." Butler (1906) states that the spores are more or less sickle-shaped, undivided, and measure from 20-30 μ in length and 5-7 μ in breadth. They contain a large refractive dot in the center. The setae are dark greenish brown with several septa and are about 4-6 times as long as the spore.

The writers' specimen of *Collectotrichum falcatum* on sugar cane produced poorly defined acervuli. They were of different sizes although somewhat circular in shape. The diameter ordinarily measures from 150 to 270 μ, average, 225 μ. The setae are abundant, irregularly arranged, dark greenish brown at the proximal end but almost colorless at the distal end. The setae are 97.2-144.0 × 5.4-7.0 μ with 2 to 6 septa, (fig. 2). The conidiophores are short, hyaline, non-septate and filiform (fig. 2). Their average size is 16.60 × 3.86 μ. The conidia are falcate, one-celled, colorless and 27.0-34.2 × 4.3-6.8 μ. Either terminal or intercalary chlamydospore-like bodies are produced in the vegetative hyphae.

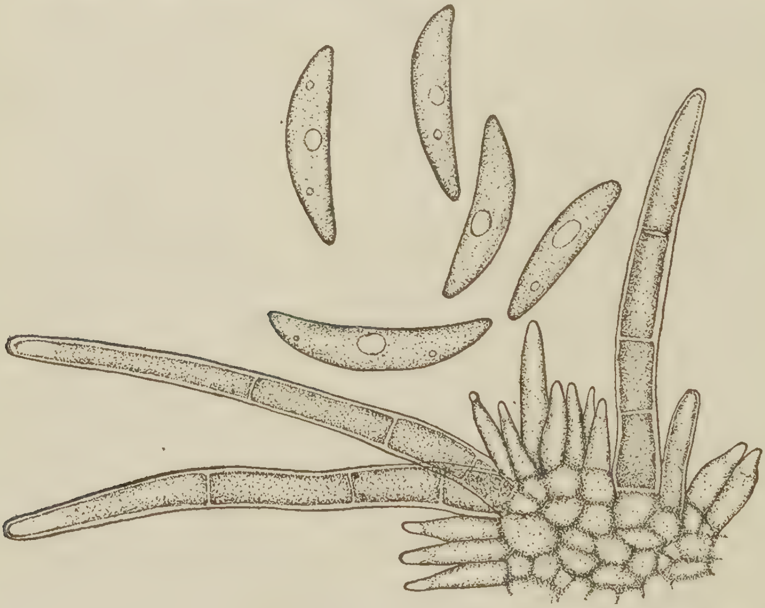

Fig. 2.—Part of a fruiting body or acervulus of the red-rot fungus *Colletotrichum falcatum* Went showing conidiophores, conidia and setae. Camera lucida drawing by the senior author. Magnification × 200.

Inoculation experiments

The pathogenicity of *Colletotrichum falcatum* Went was tested in (*a*) soil inoculation, (*b*) seed-piece inoculation, (*c*) spore-suspension inoculation, (*d*) inoculation through wounds. These inoculation experiments were conducted in both the laboratory of the Department of Plant Pathology and in the field.

Soil inoculation. Edgerton and Moreland (1920) report that *Colletotrichum falcatum* is one of the causes of deterioration of cane points. Investigators differ in opinion in regard to infection of young cane plants with red rot. The writer conducted two experiments to determine if the causal agent when present in the soil is able to infect the seed-cane pieces.

Experiment 1. Healthy plants of Mauritius 1900, one to three months old, grown in sterilized common garden soil[2] in kerosene cans were inoculated by mixing thoroughly a two-week old culture of the fungus on potato-dextrose agar with the soil around the base of the plant. In removing the soil, care was taken not to injure the roots. Control plants were treated in the same manner except that sterile potato-dextrose agar was used as inoculum instead of pure culture of the fungus. The inoculated and check plants were left for five days in a shady place and then exposed to the open air. In this first experiment no marked change between the checks and the inoculated plants was noted after 30 days. Two of the checks died from insect-borer attack but they were free from red rot.

Experiment 2. The second soil-inoculation experiment was performed as in experiment 1. Ten canes were inoculated and five canes were used as checks. The same result as in the first experiment was obtained.

Seed-piece inoculation; Experiment 1. On January 22, 1933, 18 two-node cuttings of POJ 2878 sugar cane were inoculated by smearing on the cut ends of the seed pieces, 15-day-old cultures of the fungus grown on plain steamed oatmeal. Immediately after inoculation the cuttings were planted in pots containing sterilized soil. The same number of cuttings smeared with plain steamed oatmeal were similarly planted for checks. On February 14, 1933, the inoculated canes showed 100 per cent germination while the checks produced 94.4 per cent. One of the points in the checks died of pineapple disease caused by the fungus *Ceratostomella paradoxa* Dade. The result of this experiment tends to show that under Philippine conditions the fungus does not cause deterioration of cuttings used for seed purposes.

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[2] The sterilized soil used in all of the experiments was heated on a piece of sheet iron directly over the fire for not less than one hour with constant stirring to prevent the burning of the organic matter.

Two other experiments following the same method were performed but with negative results as the fungus *Ceratostomella paradoxa* Dade invariably infected the seed pieces.

Inoculation with spore suspension. Although the fungus is generally regarded as a wound parasite the writer attempted to infect canes by spraying and smearing spores and mycelium of the *Colletotrichum* from culture on sound aërial parts of the plants.

Experiment 1. On November 6, 1932, 25 healthy plants of Mauritius 1900 about four months old, were transplanted in sterilized soil in kerosene cans, and inoculated with spores suspended in sterile water sprayed upon the plants. Another 25 plants of the same variety and age were sprayed with sterile water to serve as checks. The plants were then placed in the shade protected from strong winds. To be sure that the inoculated plants had abundant spores on them, the next day they were sprayed again with another spore suspension. The controls were sprayed with sterile water. A week later, the plants were placed outside for observation. Infection was noted on the leaves of both control and inoculated plants. The infections were found to be due to punctures made by *Perkinsiella vastatrix* Breddin. The unpunctured midribs, however, were not infected.

Experiment 2. On January 7, 1933, nine stalks of Mauritius 1900, six months old were inoculated by smearing fresh spores on normal adventitious roots and eyes. Eight stalks served as checks. On March 16, 1933, the canes were split but there was no sign of infection in either the control or the inoculated lots.

Experiment 3. On January 7, 1933, six healthy stalks of Mauritius 1900, about six months old, were inoculated by smearing spores from 12-day-old cultures on steamed oatmeal on the eyes and on old leaf scars. The stalks were disinfected with 1:1000 solution of mercuric chloride and rinsed with sterile water. Three plants which served as checks were kept moist by wrapping them with wet absorbent cotton. Both the inoculated stalks and checks were placed in a cool place. On March 18, 1933 only one stalk showed infection. The infected stalk, however, was attacked by a borer. The control plants remained healthy.

Experiment 4. On February 1, 1933, ten stalks of POJ 2878 canes, eight months old, were smeared on the eyes and leaf scars with spores with a moist sterilized camel's hair brush. Five plants were used as controls. On March 16, 1933 both the inoculated and check plants were found to be free from infection.

Inoculation through wounds. Lewton-Brain (1908) and Edgerton (1911) invariably used the needle puncture method for inoculating canes. Butler (1913) used the same method and a sterile cork borer to make the wound in the rind.

In field inoculations made by the writers the sites of inoculation on the stalks and on the leaves were disinfected with 1:1000 mercuric chloride solution which was rinsed off with sterile water afterwards. The inoculum was introduced either through needle punctures on the leaves or through a hole bored in the stalk with a sterilized five-millimeter cork borer. The plants used for inoculation were either growing in the field or in pots. The results of these experiments are summarized in table 1. Table 1 shows that in almost all of the inoculations the writers secured positive infections. In the stem-wound inoculation, the fungus from the leaf was used for inoculation and typical symptoms of red rot were produced. The results of these experiments seem to prove that the stem and leaf fungus are identical.

The results obtained from all of the experiments described above prove that the fungus is unable to infect canes without there are injuries on them.

The fungus was reisolated from each inoculated plant.

Susceptibility to red rot of different varieties of sugar cane

In a number of papers on red rot of sugar cane, the statement is made that some varieties are more susceptible to the disease than others. Lewton-Brain (1908) found that Yellow Caledonia, although not immune to the disease, is quite resistant to it. Butler (1906) points out that Yellow Bourbon was badly diseased while other varieties growing in close proximity to the diseased canes were not attacked. Abbott (1931) listed the varieties in the order of their susceptibility to red rot, beginning with the most susceptible: C.P. 807. POJ 213, POJ 36, 36M, Co. 281, and POJ 234. Serrano and Marquez (1923) of the Philippine Bureau of Plant Industry recommend Badila, Hawaii 109, Demarara 1135, and Uba as resistant varieties for planting. Abbott (1933) states that there are two kinds of resistance to *C. falcatum;* namely, functional and physiologic.

Different sugar cane varieties were examined in an effort to determine the degrees of susceptibility to red rot. A survey of the occurrence of the disease in the collection of sugar cane varieties of the Department of Agronomy, College of Agriculture, Los Baños was made. Fifty plants of each variety were examined carefully for the presence of the disease. The result of the survey is shown in table 2. It may be seen in this table that varieties differ considerably in degree of infection with the disease. The result of this examination, however, does not necessarily mean that the freedom from red-rot disease is actually due to resistance. It may mean that the freedom from infection was due to the fact that no inoculation actually took place among them.

To determine whether or not there are varieties of canes resistant to the disease, inoculations of different varieties grown in pots were made. Two months after inoculation the stalks were split into halves and the length of the lesions was measured. In this experiment the results showed that Pampanga Red had a lesion of about 65 cm.; Luzon white, 62 cm.; Badila, 60 cm.; Wailuku No. 2, 30 cm.; Mauritius 1900, 25 cm.; Hawaii 109, 20 cm.; Zambales White, 25 cm.; and POJ 2878, 15 cm. These results indicate that Pampanga Red, Luzon White, Wailuku No. 2, Mauritius 1900, and Zambales White are quite susceptible to red rot. POJ 2878, Hawaii 109, and Linabnig are more resistant. The results of this experiment tend to confirm the field observations on the susceptibility of different varieties of sugar cane. With the varieties used in the present work, however, none was found to be immune to the disease, but they differ in their susceptibility. The writers considers the following varieties susceptible to red rot in the order given: Wailuku No. 2, Pampanga Red, Luzon White, Mauritius 1900, Zambales White, Malagache, C.A.C. 87, Badila, POJ 2714, Hawaii 109 and POJ 2878.

Seasonal appearance of the disease

Red rot infection of cane stalks is abundant at the beginning of the milling season. The disease becomes common in the cane fields during November, December, January, February and March. The writers observed that red rot is less frequent during the growing season but becomes widespread toward the harvesting season. Infected mature canes when ratooned reproduce the disease in the growing season. On the leaves, the disease is found throughout the year, but is more abundant during August, September, October, November, December, and January. Leaf infection may serve as a constant source of red rot infection of the stalks.

Production of spores

On the stalks and leaves. Spores are formed in the advanced stages of the disease. On the infected midrib, acervuli are formed on the pale straw colored area of the lesions.

Viability of the spores. The writers found that spores from a diseased stalk put in moist dishes in the laboratory July 2, 1932, and kept moist, were still viable on January 2, 1933 after a period of about six months. Spores from culture media kept in the laboratory were found to germinate after five months. Stalks of diseased canes exposed to the weather for three months produced spores which were viable. Butler (1906) found that spores buried in the soil at a depth of 7.6 centimeters germinated after eight weeks but died within three months. Lewton-Brain (1908) found that spores from dried plate cultures showed no sign of vitality after three months.

Spore dissemination

Spore-catching experiments were carried out to determine if the spores of *C. falcatum* are carried by wind. On February 1, 1933, 25 clean glass slides were smeared with a thin film of vaseline on one side. The slides were placed around the cane fields where there were infected stalks and leaves. After 24 hours, microscopic examination of the slides showed that they contained conidia of *C. falcatum.* On February 5, 1933, 25 glass slides with blocks of a thin layer of water agar placed on them were used for catching the spores. After 16 hours, spores of *C. falcatum* were found on the agar. Five Petri dishes containing water agar were exposed on February 10, 1933. Three of the dishes caught several spores during 24 hours of exposure. The results of these experiments seem to show that wind aids in dissemination of the spores. In the laboratory, spore masses were placed in tap water on the slides. The slimy matrix holding them was diluted and the conidia were readily scattered. The same behavior was noted by Malabanan (1925) in *Colletotrichum nigrum.* The authors suggest that water aids in dislodging the spores from the matrix rendering them easy to disseminate. As to the borer and leaf hoppers it is believed that these insects play an important rôle in the dissemination of spores.

Method of infection

In general, most workers hold that the fungus is a wound parasite. This opinion was confirmed when the writers found in a survey of canes infected with red rot that infection usually accompanied injuries made by certain cane borers. Of all the cane borers, *Olethreutes schistaceana* Snell is the most destructive; *Diatraea venosata* Walker is only so to a slight extent. Aquino (1921) found that the moth borer, *Diatraea saccharalis* F. bores holes in the rind, thus providing entrance for the red-rot fungus. In one instance, the writers found that *Rhabdocnemis lineatocollis* had produced on stalks some openings which resembled borer tunnels. These openings were followed later by red-rot infection. Rats to some extent were responsible for the wounding of some cane stalks observed at Canlubang, Laguna. These animals aid in producing avenues of entrance for the parasite. To determine the relation of borer infestation to the occurrence of the disease, 500 stalks selected at random before milling were examined for the presence of borer holes and the red-rot disease. Of the 187 stalks infected, in 143 or 76.5 per cent were borer holes. There were 50 stalks with borer holes which were not infected with red rot. In nearly 98 per cent of the leaves found with the characteristic reddening on the midrib, red-rot infection appeared in places either punctured with the ovipositor of *Perkinsiella vastatrix* Breddin or injured by other means.

Existence between seasons

Throughout the year the fungus may be found as an active parasite on the leaves of sugar cane. When ratooning is practiced, the fungus tides over between seasons either in the infected cane trash or in the infected stubble. In the infected cane trash the fungus lives as a saprophyte and unless the trash is properly disposed of this will harbor the parasite and serve to hold the fungus over and it becomes an active parasite in the following season.

CONTROL MEASURES

Seed selection

To obtain cuttings free from red rot it is essential that sugar cane growers practice seed selection. Any canes showing discoloration of the interior tissues should be rejected.

Use of resistant varieties

The writers found that different varieties vary in their susceptibility to red rot. In the West Indies, varieties not affected with red rot are used for seed purposes. Serrano and Marquez (1923) regarded this method of controlling the red-rot disease as the most important. These authors recommend the planting of Badila, Hawaii 109, Demarara 1135, Uba etc., instead of Luzon White. The writers noted that POJ 2878, Hawaii 109, and Linabnig are quite resistant to red rot in the College and recommend the use of these varieties for controlling the disease.

Elimination of sources of infection

After harvest in infected fields all diseased clumps, cane debris, and infected leaves should be gathered, piled in one place and burned. Diseased cane materials if allowed to remain in the field serve as a good medium to keep alive for some time the fungus which produces spores. Some cane planters use the bagasse as fertilizer. This practice if the bagasse is infected with the red-rot fungus is dangerous as the fertilizer becomes a source of infection.

Butler (1906) found that ratoons from a diseased stock are invariably diseased. In the Philippines the same condition holds true. Therefore, in fields where the disease has been particularly severe, ratooning should not be practiced.

SUMMARY AND CONCLUSIONS

1. Red rot is one of the common diseases of sugar cane in the Philippines. Usually, however, it does not become serious. Only sporadic outbreaks occur in certain localities.

2. The disease was first reported and its causal fungus described in 1893 by Went in Java. In the Philippines red rot was first reported by Reinking in 1919.

3. The disease is widely distributed in the tropics and in a few sub-tropical countries. Under Philippine conditions, red rot does not materially affect the tonnage of sugar cane but it reduces the sucrose content. In this country, the disease does not materially affect the germination of cane points.

4. Red rot in the stem in early stages has no external symptoms; but in advanced stages a gradual withering of the foliage is noticeable. On splitting the canes the disease is shown by the presence of red discolorations traversed by white areas. On the leaves, the red rot discoloration shows very clearly on the upper surface of the midribs.

5. The causal organism may be readily isolated by directly plating the spore growing on tissues which have been incubated and allowed to sporulate. The morphological and cultural characteristics of red rot and its pathogenicity are identical with those of *Colletotrichum falcatum* Went.

6. Some sugar cane varieties are more susceptible to the disease than others, some are quite resistant, but none is highly resistant.

7. The fungus is a weak parasite. It is capable of attacking canes only after they have been weakened and wounded by insects and mechanical agencies.

8. Infected dried stalks, leaves and clumps are important sources of inoculum. Dissemination of the fungous spores is accomplished by wind, rain drops, insects and irrigation water.

9. For control of red rot it is important to practice seed selection, to use resistant varieties, to eliminate sources of infection and not to ratoon in serious cases.

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TABLE 1

Summary of inoculations on the sugar cane stalks and leaves made through wounds

EXPERIMENT NO.	PLACE OF WORK	NUMBER OF STALKS AND LEAVES USED		VARIETY USED	AGE OF CULTURE	PERIOD FROM INOCULATION TO EXAMINATION	INFECTED	INFECTION	AV. LENGTH OF INFECTION
					days	*days*	*number*	*per cent*	*cm.*
1	Field	Inoculated	5	POJ 2878	14	21	5	100.00	6.0
		Control	5	....	—	21	—	—	—
2	Field	Inoculated	15	POJ 2878	9	84	14	93.33	15.0
		Control	15	....	—	84	—	—	—
3	Field	Inoculated	19	POJ 2878	30	69	18	94.73	8.0
		Control	8	....	—	69	—	—	—
4	Field	Inoculated	18	POJ 2878	30	67	18	100.00	14.0
		Control	12	....	—	67	2	16.66	3.5
5	Field	Inoculated	21	POJ 2878	14	63	21	100.00	10.0
		Control	10	....	—	63	—	—	—
6	Field	Inoculated	37	Linabnig	10	70	37	100.00	11.0
		Control	34	....	—	70	—	—	—
7	Laboratory	Inoculated	10	M-1900	10	24	9	90.00	14.0
		Control	5	....	—	24	—	—	—
8	Laboratory	Inoculated	8[a]	M-1900	7	4	8	100.00	1.0
		Control	8	....	—	4	—	—	—
9	Laboratory	Inoculated	10[a]	M-1900	10	5	10	100.00	2.0
		Control	10	....	—	—	—	—	—

[a] Leaves.

TABLE 2

Showing the relative susceptibility of eleven cane varieties

VARIETY	STALK	HEALTHY	INFECTED	INFECTION
	number	*number*	*number*	*per cent*
Wailuku No. 2	50	35	15	30
Pampanga Red	50	40	10	20
Mauritius 1900	50	40	10	20
Luzon White	50	41	9	18
Zambales White	50	42	8	16
Malagache	50	45	5	10
C. A. C. 87	50	46	4	8
Badila	50	47	3	6
POJ 2714	50	48	2	4
POJ 2878	50	50	—	—
Hawaii 109	50	50	—	—

PROTEIN SUPPLEMENTS IN POULTRY RATIONS: IV. THE INFLUENCE OF DRIED BUTTERMILK IN A RATION CONTAINING THE OPTIMUM AMOUNT OF SHRIMP MEAL FOR GROWING CHICKS[1]

F. M. Fronda and Tranquilino V. San Pedro

WITH ONE CHART

Milk, in all forms, is considered an essential part of chick rations; in fact poultry raisers in countries where milk products can be secured at a reasonable price consider it poor management if milk products are not included in their poultry rations. The different milk products are considered essential in chick feeding because they contain proteins that are easily digested and are of value (Jull, 1930). The results of an investigation by Norris, Heuser and Wilgus (1930) suggest that milk contains also a "hitherto unrecognized factor essential for the prevention of a peculiar type of paralysis in poultry involving the legs and feet, and which is indirectly growth promoting."

Milk products may be fed in various forms—liquid, semi-solid, condensed and dried. Card (1926), comparing different forms of milk in a ration for growing chickens, concluded that "the question of whether to use sour skim milk, fresh buttermilk, condensed buttermilk or dried buttermilk will not depend upon a difference in nutritive value but upon such factors as: (1) convenience in feeding, (2) the importance, in certain instances, of maintaining the protein intake at a constant percentage of the total ration; and (3) the availability and cost of the various forms of milk."

Massengale (1929) reported that chicks receiving a mash plus skim milk to drink made better and more uniform growth than those receiving the same mash plus some other forms of milk. Card (1926) obtained uniform growth when dry milks were used because the chicks could get a constant amount. Comparing dried butter-

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[1] The data presented in this paper were taken from the thesis presented by the junior author for graduation, March, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 453; Experiment Station contribution No. 1035. The thesis was prepared under the direction of Dr. F. M. Fronda, Assistant Professor of Poultry Husbandry.

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milk and dried skim milk, both manufactured by the same process, Musséhl and Ackerson (1931) noted a significant difference between the two, and this difference was in favor of the dried buttermilk.

Dried buttermilk is now available to Philippine poultry raisers. It should be of timely interest to know the influence of the addition of this valuable chick feed to a ration containing the optimum amount of shrimp meal fed to growing chicks (1934). Considering that dried buttermilk is an expensive feed,[2] to know the best proportion in which shrimp meal and dried buttermilk may be incorporated in chick rations should be of value to local poultry raisers.

It may be mentioned in this connection that Carver, *et al* (1932) using dried skim milk powder, reported that they obtained the most rapid rate of growth during the first ten weeks on a protein level of 18 per cent. Massengale (1929) also reported that chicks that received a mash containing approximately 5 per cent meat scrap with skim milk or liquid semi-solid buttermilk to drink made better growth than those that received a mash containing 15 and 17.5 per cent meat scrap but with water to drink.

Roberts and Carrick (1933) combined meat and bone scraps and dried skim milk in the proportions of 3 parts meat and bone scraps to 1 of dried skim milk, 1 part of meat and bone scraps to 1 of dried skim milk, and 1 part of meat and bone scraps to 3 of skim milk, the ration containing 20 per cent of the combination. They observed that there was no difference in the rate of growth or mortality during the first 10 weeks.

The present work was conducted from February, 1933 to January, 1934. The objects were: (*a*) to compare the feeding values of dried buttermilk and shrimp meal as supplements for growing chicks; and (*b*) to determine the best combination of these feeds in rations for chicks.

PLAN OF THE STUDY

A total of 360 Los Baños Cantonese chicks hatched in June, August, and October, 1933, were used in this experiment. The chicks from each hatch were divided into five lots. The first hatch had 21 chicks to the lot; the second hatch, 22 chicks and the third hatch, 29 chicks making a total of 72 chicks in each lot for each of the three trials observed. These chicks were raised in fireless brooders and were allowed a sufficient grass range.

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[2] This feed, at the time that these experiments were conducted, cost ₱16.00 a sack of 100 pounds or ₱0.352 a kilogram.

The basal ration used in this experiment consisted of fine grade rice bran and yellow corn meal. In addition to this ration, shrimp meal and a commercial brand of dried buttermilk, "Peeble's Dry Buttermilk", were used as supplements, singly and in combination in the proportions shown in the following table:

INGREDIENTS	LOT I	LOT II	LOT III	LOT IV	LOT V
	All shrimp meal (control)	75% shrimp meal and 25% dried buttermilk	50% shrimp meal and 50% dried buttermilk	25% shrimp meal and 75% dried buttermilk	All buttermilk
	parts	*parts*	*parts*	*parts*	*parts*
Rice bran	56.25	56.25	56.25	56.25	56.25
Corn meal	18.75	18.75	18.75	18.75	18.75
Shrimp meal	25.00	18.75	12.50	6.25	—
Buttermilk	—	6.25	12.50	18.75	25.00

The following table shows the compositions of the feeds used in this study as analyzed by the Department of Agricultural Chemistry, College of Agriculture.

CONTENTS	CORN MEAL	RICE BRAN	DRIED BUTTERMILK	SHRIMP MEAL
	per cent	*per cent*	*per cent*	*per cent*
Moisture	13.41	9.20	11.01	14.55
Fat (ether extract)	7.56	13.89	0.38	2.61
Ash	2.79	10.11	7.77	19.73
Protein (N × 6.25)	1.78	12.38	26.13	55.61
Crude fiber	3.19	9.72	—	4.20
Carbohydrates	71.27	44.70	54.71	3.26

It may be noted here that shrimp meal has twice the protein content of dried buttermilk. In the carbohydrate content, however, buttermilk has more than shrimp meal. In the fat, ash, and moisture contents shrimp meal has a little more than the dried buttermilk. Thus, it may be seen that to make the buttermilk ration contain as much protein as the shrimp meal ration, the buttermilk had to be doubled in amount. As the economy of the ration had to be considered, this would have been impractical, buttermilk being an expensive feed.

The following table shows the proximate analyses of the different feed mixtures used in this experiment based on 100 kgm. mixture:

CONSTITUENT	MIXTURE I	MIXTURE II	MIXTURE III	MIXTURE IV	MIXTURE V
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Moisture	11.31	11.10	10.81	10.59	10.37
Fat	9.87	9.73	9.10	9.45	9.31
Ash	11.14	10.40	9.65	8.89	8.15
Protein	21.19	19.36	17.51	15.66	13.82
Crude fiber	7.11	6.85	6.59	6.32	6.06
Carbohydrates	39.31	42.53	45.74	48.95	52.17

The chicks were fed all-mash. The troughs were kept filled during the day, moistening the mash at noon to render it more palatable. Fresh drinking water was given *ad libitum* and the drinking troughs were accessible to the birds at all times during the day.

Accurate records of the feed consumption were taken weekly. The initial weights of the chicks were taken at hatch and they were weighed weekly thereafter up to twelve weeks. The mortality in each lot was also recorded and minor observations on the vigor and activity of chicks were recorded.

RESULTS AND DISCUSSIONS

Effects of feeds on growth. The average rate of growth of chicks in the different lots of the three trials observed are presented in table 1 and graphically in chart 1. By reference to these records, it may be seen that the initial weight of the chicks in each lot did not vary much. It may also be seen that there were no noticeable differences in the average weight at one week of age. At the age of four weeks, however, differences in the average weights of the chicks may be seen. The chicks in the lots that received the combination supplements had higher average weights than either of the lots that received all the supplements, all shrimp meal and all buttermilk. These differences are, however, not statistically significant.

At the age of eight weeks the same trend of growth may be noted. It is apparent that among the combinations used the 50 per cent–50 per cent combination of shrimp meal and buttermilk leads in the average weight, although the differences when treated statistically are still not significant. However, there is a slight significance when lot III is compared with lot V.

At twelve weeks old lot III (50 per cent shrimp meal and 50 per cent buttermilk) maintained the highest weight among the lots, followed by lot II, (75 per cent shrimp meal and 25 per cent buttermilk), and lot IV (25 per cent shrimp meal and 75 per cent buttermilk), as close seconds, lot I (shrimp meal lot) was third; and lot V (buttermilk lot) had the lowest average weight. When these averages were compared statistically, it was observed that there was a significant difference when lot V was compared with each of the other lots, whereas lots I, II, and IV present no significant differences when compared with one another. Lot III showed a significant difference when compared with lots I, II, and IV.

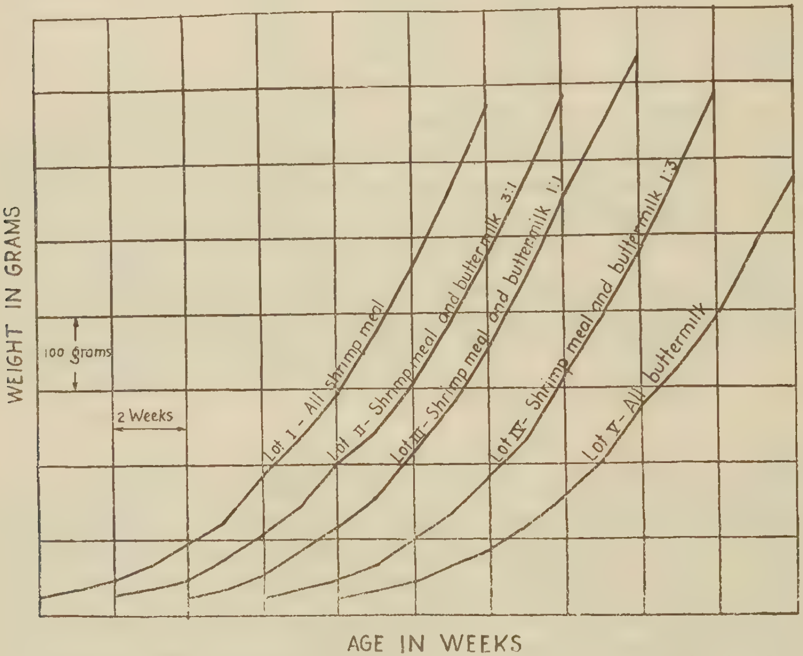

Chart 1.—Showing the average rate of growth of the chicks in the different lots.

Probably the variation in the average final weights was due to the effects of the different combinations of shrimp meal and dried buttermilk in various proportions, as 75 per cent shrimp meal and 25 per cent buttermilk; 50 per cent shrimp meal and 50 per cent buttermilk; and 25 per cent shrimp meal and 75 per cent buttermilk. With these combinations, the rate of growth is slightly improved. These results corroborate the statement of Edwards (1925) that dried buttermilk when combined with other feeds developed remarkable results in building up of baby animals. The results show also that by comparing the efficiency of shrimp meal and buttermilk as supplements the former has a greater growth-promoting value than the latter. This superiority is probably due to the fact that shrimp meal contains almost twice as much proteins as dried buttermilk; proteins are a very essential nutrient for growth.

Feed consumption and cost. The total feed consumption of the different lots during the three periods, computed on the basis of 100 birds, is shown in table 2. This consumption was computed on this basis so that a more direct comparison of the feed consumed may be possible.

It may be noted in table 2 that the addition of dried buttermilk did not apparently increase the palatability of the ration. The slight differences that may be observed in the feed consumption of lots I, II, III and IV may be because the birds in these lots were larger than those in lot V, hence, they would be expected to consume more feed. The ration supplemented with dried buttermilk alone was apparently not as palatable as the other rations studied.

From these figures it appears that the birds in lot I consumed ₱0.177 worth of feed per bird up to 12 weeks old; those in lot II, ₱0.229; those in lot III, ₱0.277; those in lot IV, ₱0.329; and those in lot V, ₱0.306. It is obvious then that lot I required the lowest cost of feeds per bird, and lot IV the highest. This was because buttermilk costs almost three times as much as shrimp meal.

The returns over the cost of feeds are also shown in table 2. These were computed by subtracting the cost of feeds consumed per 100 birds from the income to be obtained from 100 birds if sold at 60 centavos per kilogram live weight. By reference to this table, it may be noted that it seems that the returns above the cost of feeds decrease as the amount of buttermilk in the ration is increased. Therefore, it may be concluded that shrimp meal is the more economical supplement. These results show that although there is little improvement in the rate of growth of chicks by the combination of shrimp meal and dried buttermilk this advantage is offset by the price of feeds. If it is desired, however, to obtain the best results without regard to cost then 50 per cent shrimp meal and 50 per cent buttermilk should be used as supplement.

Effects on the mortality of chicks. The mortality of chicks during the three trials is given in table 3. It may be noted in this table that lot III had consistently the lowest percentage of mortality in all the trials, and lot I had the highest. The mortality during the third trial was raised in all lots because the chicks were infected by a disease that appeared to be coccidiosis. It is plain, however, that the mortality was less in the lots in which the ration was supplemented with the combination of shrimp meal and dried buttermilk. The lot that received the all-buttermilk supplement had a lower percentage of mortality than the one that received the all-shrimp meal supplement. It appears, therefore, that buttermilk is better than shrimp meal in reducing mortality. Card (1926) working on the feeding value of different forms of milk as supplement for growth, reported that dried buttermilk was the best form to increase growth and lower the percentage of mortality.

Minor observations: *Sexual development.* It was observed that the development of the secondary sexual characters of the males,—as the comb and wattles,—was earlier in the shrimp meal lot than in the combination lots or the buttermilk lot. The cockerels in lot I had noticeably developed combs and wattles as young as three to five weeks of age.

Feathering. Early feathering was noticed in lot I and the combination lots. The feathering in lot V was quite late. At four weeks of age the chicks in lots I to III were observed to be wholly covered with feathers. This early and heavy feathering was caused perhaps by the sufficiency of protein in the feed, giving an excess to be used for the development of feathers.

Vigor and activity. The chicks in all the lots were vigorous and active. It was noticed that the chicks in lot V were better grazers than those in lot I. It was observed that while the grass in lot I was not depleted, the yards of lots II to V were bare. This difference in grass consumption was due perhaps to the insufficient protein in the ration of the buttermilk lot so that the green feed was eaten to satisfy the craving for proteins.

SUMMARY AND CONCLUSIONS

The effects of a combination of shrimp meal and dried buttermilk on the growth of chicks are reported in this paper. The results obtained may be summarized as follows:

1. The combination of shrimp meal and dried buttermilk in various proportions used in this experiment slightly improved the rate of growth of chicks.

2. The combination of 50–50 per cent of shrimp meal and dried buttermilk was the best in influencing growth of chicks and in reducing mortality.

3. Shrimp meal was better than dried buttermilk when used singly as supplement in rations for chicks.

4. The addition of dried buttermilk did not apparently increase the palatability of the ration.

5. The combinations of shrimp meal and dried buttermilk in the proportions used in this experiment tended to reduce the percentage of mortality of the chicks.

6. From the economic point of view, the use of a ration containing 25 per cent shrimp meal alone is recommended for growing chicks.

7. If it is desired, however, to obtain the best results without regard to cost it is recommended that the 50 per cent shrimp meal and 50 per cent dried buttermilk combination be used.

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TABLE 1

Showing the average weekly weights of chicks in the different lots up to 12 weeks old

AGE	LOT I ALL SHRIMP MEAL (CONTROL)		LOT II 75% SHRIMP MEAL AND 25% DRIED BUTTERMILK		LOT III 50% SHRIMP MEAL AND 50% DRIED BUTTERMILK		LOT IV 25% SHRIMP MEAL AND 75% DRIED BUTTERMILK		LOT V ALL DRIED BUTTERMILK	
	Number of chicks	Average weekly weight	Number of chicks	Average weekly weight	Number of chicks	Average weekly weight	Number of chicks	Average weekly weight	Number of chicks	Average weekly weight
		grams		*grams*		*grams*		*grams*		*grams*
1 day	72	24.59 ± 1.2067	72	24.61 ± 1.3333	72	24.30 ± 1.3286	72	24.35 ± 1.1461	72	23.99 ± 1.2340
1 week	65	31.87 ± 0.5416	67	34.17 ± 0.2717	70	35.63 ± 0.0552	67	34.56 ± 0.6650	68	31.92 ± 0.8363
2 weeks	63	46.77 ± 1.8063	66	46.24 ± 2.7606	70	53.76 ± 1.9564	65	49.86 ± 2.3807	63	44.43 ± 1.8818
3 "	58	65.55 ± 4.1524	65	70.19 ± 5.6916	69	77.57 ± 5.2075	64	68.36 ± 3.3355	61	65.59 ± 3.2578
4 "	55	95.23 ± 10.7339	59	107.65 ± 16.8191	69	117.13 ± 13.1743	60	102.52 ± 11.4167	59	86.23 ± 7.5139
5 "	54	127.56 ± 12.0081	57	143.89 ± 17.9073	67	155.87 ± 19.1272	59	135.36 ± 14.8822	57	117.08 ± 13.2269
6 "	54	183.48 ± 7.8147	57	204.09 ± 22.1157	64	217.86 ± 16.6106	57	183.93 ± 19.1557	56	157.03 ± 10.6841
7 "	50	230.59 ± 6.1036	55	242.10 ± 21.2955	62	276.27 ± 20.3778	57	235.02 ± 14.5465	55	205.48 ± 16.0935
8 "	50	294.95 ± 8.8359	54	306.24 ± 24.4622	62	353.71 ± 25.6070	57	315.51 ± 28.4781	54	269.08 ± 15.6417
9 "	50	371.84 ± 10.6925	53	389.75 ± 27.4371	62	451.83 ± 23.0071	57	394.61 ± 33.7115	54	325.20 ± 16.6871
10 "	50	462.43 ± 25.4893	53	478.24 ± 26.1369	62	554.79 ± 31.7217	57	480.35 ± 40.5644	54	394.15 ± 28.8213
11 "	50	566.60 ± 32.4457	53	575.90 ± 32.3478	62	649.74 ± 21.9954	57	584.63 ± 30.7175	54	483.14 ± 37.1403
12 "	50	673.16 ± 18.3733	53	687.40 ± 13.8879	62	736.12 ± 10.8527	57	691.42 ± 9.2194	54	571.29 ± 16.7343

TABLE 2

Showing the cost data

ITEMS	LOT I	LOT II	LOT III	LOT IV	LOT V
1. Cost per 100 kgm. ration[a] (₱)	5.89	7.33	8.77	10.21	11.66
2. Actual amount of feed consumed by the different lots up to 12 weeks old. (kgm.)	159.3	172.9	201.1	185.0	147.8
3. Cost of total feed consumed. (₱)	9.38	12.67	17.63	18.89	17.23
4. Amount of feeds consumed on the basis of 100 birds up to 12 weeks old. (kgm.)	301.1	311.9	315.3	322.0	362.6
5. Cost of feeds consumed per 100 birds up to 12 weeks old. (₱)	17.73	22.86	27.65	32.87	30.62
6. Average weight of chicks at 12 weeks old. (grams)	673.16	687.40	736.12	691.42	571.29
7. Value of 100 birds @ ₱0.60 per kgm. live weight. (₱) .	40.39	41.24	44.17	41.48	34.27
8. Returns over the cost of feeds per 100 birds. (₱)	22.66	18.38	16.52	8.61	3.65

[a] The costs per kilogram of the feeds used were:

Rice bran	₱0.036
Corn meal	0.044
Shrimp meal	0.121
Dried buttermilk	0.352

TABLE 3

Showing the percentage of mortality of chicks in the first 12 weeks

LOT NO.	TRIALS			AVERAGES
	1	2	3	
	per cent	*per cent*	*per cent*	*per cent*
I	28.57	22.72	41.37	30.88 ± 3.7145
II	14.28	18.18	41.37	24.61 ± 5.7030
III	9.52	9.09	20.68	13.09 ± 2.5588
IV	9.52	18.18	31.03	19.57 ± 4.2146
V	14.28	22.72	34.48	23.82 ± 3.9509

AN EXPERIMENTAL SURVEY OF THE RELATIVE NUTRITIVE VALUES TO YOUNG COCONUT PALM OF FERTILIZERS ADDED TO TUFF SOIL IN POTS[1]

VALERIANO O. VALENOBA

INTRODUCTION

During the last few years there has been considerable increase in the use of fertilizers by Filipino farmers. And the number of single and mixed fertilizers on the market has rapidly increased. The name of one *mixed* fertilizer, Corona Cocos, suggests that it is good for the coconut palm regardless of variations in soil, climate, or other conditions that may be present in different coconut plantations. But experience with other crops has shown that variations in soil and in climate tend to produce also variations in the effects of the fertilizers upon the plants. Considering this and the number of fertilizers on the market it appeared desirable to make an experimental survey of the relative nutritive values to young coconut palm, of some of the common single and mixed commercial fertilizers now on sale in the Philippines.

Literature on commercial fertilizer tests with the coconut in the Philippines is still very limited. Copeland (1911) reports that the average growth of all leaves of fertilized coconut trees was greater than that of the unfertilized trees, and that a marked difference was observed in the older leaves, indicating that the leaves of the fertilized trees continued to grow for a longer time than the leaves of the unfertilized trees. Copeland further reports that the vigor of the tree was increased as a direct result of the increases in the size of the leaves.

From the results of analyses of the different products of the coconut made by chemists, Copeland (1921) drew the tentative conclusion that potash, nitrogen and phosphorus are the fertilizing materials for the coconut. He writes that "it may be accordingly stated as probably a correct conclusion that of the three most important fertilizing substances, the coconut in general demands potash first, nitrogen next or with it and then phosphorus". Copeland cites results published by the German Potash Syndicate to the effect that the application of potash was profitable to the plant and to the grower. He reports that it has been found here (Philippines) and in private plantations in Ceylon, that the application of potash has resulted in a sufficiently more thrifty development to make the treatment decidedly profitable.

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[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, No. 449; Experiment Station contribution No. 1028. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

Bacomo (1917) in connection with his observations on the effects of commercial fertilizers on coconut seedlings grown in clay loam soil in the field reports that plants supplied with 131.6 grams of ammonium sulfate (or 26.3 grams NH_3) gave the highest average growth. He also reports that the plants that received 80 grams of nitrogen from nitrate of soda gave a growth increment less than that of the check, and that the greatest decrease of growth of the plant was observed following the application of 500 grams of nitrate of soda.

Fertilizer studies with the coconut palm in other countries are also limited. McClelland (1931), in a rather extensive study in Porto Rico on the effects of fertilizers on the yield of nuts, reports that the results he obtained were so variable that he deemed it not advisable to make any conclusion. He thinks that the "results do not justify the recommendation of any particular element or combination as a fertilizer for coconut".

Smith and Pape (1913) point out that young coconut plants are heavy feeders of potash and of phosphates and recommend for use in the coconut nursery compost to which basic slag and kainit are added. For regular field manuring, however, these authors recommend the following formula as fairly good: nitrogen, 30 lb., phosphoric acid, 45 lb., potash, 45 lb., and lime, 30 lb. They specifically recommend the following mixtures: No. 1, 100 lb. sulfate of ammonia, 150 lb. bone meal, 50 lb. superphosphate, 100 lb. kainit, and 50 lb. muriate of potash; No. 2, 120 lb. sulfate of ammonia, 200 lb. bone meal, 60 lb. superphosphate, 100 lb. kainit, and 70 lb. muriate of potash per acre.

According to Sydney (1929) young coconut palms newly transplanted to the field should receive the following fertilizer mixture at the rate of two pounds per plant: superphosphate, 150 lb., nitrate of soda, 150 lb., and muriate of potash, 50 lb.

Joachim (1929) examined the statistical data of the Chilaw coconut trials and found that cultivation alone could not maintain the yield of coconut. He found that the plots treated with fish manure, and those that received a mixture of sulfate of potash and of sulfate of ammonia increased the yield only a little. He found that the steamed bone meal produced the highest average yield and that a significant increase of yield was obtained from the mineral mixture and organic mixture plots.

Munro and Brown (1920) recommend basic slag, kainit, bone meal or castor bean cake to compose a mixture which should be applied at the rate of 10 to 12 pounds to each tree.

The rate of absorption of culture solutions by the roots of the coco-palm has also been studied. Espino and Juliano (1924) found that the culture solution A_4 (0.1536 gram-molecule) characterized by 1 part each of $(NH_4)_2SO_4$, KH_2PO_4, and $Ca(NO_3)_2$ and 5 parts of $MgSO_4$, was most readily absorbed by the roots of coconut seedlings. Addition of a little NaCl to this culture solution was found by Luzuriaga (1925) to accelerate the rate of absorption by the roots of the palm. On the other hand, a heavy application of NaCl retarded absorption of the culture medium. Briones (1926) reports that a more rapid growth of leaves and greater weight of tops and roots of the coconut seedlings grown in pots containing clay-loam soil were obtained from the cultures that received Espino-Juliano's 4-salt solution than from the cultures which received any of the 3-salt solution. He also reports that the addition of 0.5 cc. of common salt to Espino-Juliano's A_4 resulted in a more rapid growth of leaves and a higher yield of tops and roots of the same plant.

From the results of the survey reported in this paper, it was hoped that the single fertilizers and the mixed fertilizers that should be used for further fertilizer studies with this palm would be determined.

This study was conducted in the Experimental Garden of the Plant Physiology Department, College of Agriculture, Los Baños, Laguna, from June, 1931 to January, 1933. Six sets of cultures were made, five of which remained in pots for a period of ten months. For lack of time, the sixth set was run for only five months.

MATERIALS, METHODS AND RESULTS

The plants

Three lots of seeds of coconut palm of the Laguna type were collected at three different times from certain coconut plantations in Los Baños. The first lot consisted of 240 nuts of approximately the same size. These were planted in a seed bed. Almost all the nuts germinated, and when the young plants were about three months old, 48 seedlings of about the same size and state of development were selected. These seedlings were used in experiments 1, 2, and 3. Before transplanting the seedlings in pots, one to each pot, the seedlings, together with the nuts remaining intact, were singly and separately weighed, and the heights of the shoots were measured. The data thus obtained were used in determining the gain in height of each plant during the entire period of experiment. The data on weight were to be used in determining the net gain in weight of each plant. But this plan could not be carried out because at the time of harvesting the plants the husks of the nuts in the different cultures were found to be in different degrees of rotting.

The second lot consisted of 190 nuts of about the same size. These seeds were also planted in a seed bed. Most of them germinated and from the young plants that were obtained 56 seedlings apparently of the same size, weight, and state of development were selected; the rest were discarded. The selected seedlings were transplanted in large earthen pots containing tuff soil and were used in experiments 4, and 5.

The third lot consisted of 100 ripe nuts, of about the same size and degree of ripeness. These seeds were planted in a seed bed. A rather high percentage of germination was obtained; when large enough, 70 seedlings of about the same size and state of development were selected. The height and weight of each seedling were determined. Then the seedlings were transplanted to the culture pots containing tuff soil, one seedling to a pot, and were used in experiment. 6.

The soil used

Tuff soil was used as the solid medium in all the cultures. It was obtained from a lot on the College ground; was pulverized, sieved and thoroughly mixed. Twenty-eight kilograms of this soil were used in each culture. Samples of the soil were analyzed in the Department of Chemistry.

The cultures and experimental data

Six sets of cultures were tried in this study. Each set was considered as an experiment. In each of the six experiments the data obtained under the different criteria of results employed were recorded in a table, experiment 1 in table 1, etc. Just before harvesting, each culture was photographed. Because of their length the tables are not included in this paper. They with the photographs are on file in the Department of Plant Physiology.

Experiment 1: To determine the nutritive value to young coco-palm of Corona Cocos fertilizer when added in different amounts to tuff soil in pots.—This experiment was started on August 15, 1931 and consisted of eight duplicate cultures in which Corona Cocos fertilizer was present in different amounts. On June 25, 1932, when the plants were about ten months old, the cultures were harvested.

Experiment 2: To determine again the nutritive value to young coco-palms of the Corona Cocos fertilizer when added in different amounts to tuff soil in pots.—This experiment was started on October 5, 1931 and consisted of eight duplicate cultures to which Corona Cocos fertilizer was added in different amounts. One culture was used as control. It received no fertilizer. On August 15, 1932, when the plants were about ten months old, the cultures were harvested.

Experiment 3: To determine the comparative nutritive values to young coco-palms of commercial fertilizers when added to tuff soil in pots.—This experiment was started on August 15, 1931, and consisted of eight duplicate cultures to each of which was added a commercial fertilizer. To make the cultures comparable, the fertilizer ingredient was added to each culture at the rate of 26.3 grams. In other words, the total N-P-K content in each culture was arbitrarily chosen as 26.3 grams, following Bacomo's conclusion that 26.3 grams NH_3 as sulfate of ammonia was the best for young coco-palms. Unfortunately, in computing the amount of Corona Cocos and of Corona No. 1, the percentages of purity of these fertilizers were taken as N-P_2O_5-K_2O instead of N-P-K. Consequently, the sum total of the N-P-K contents turned out to be less than 26.3 grams. As in experiment 2, one culture was used as control and did not receive any fertilizer. On June 25, 1932, the cultures were harvested.

Experiment 4: To determine the comparative nutritive effects on the growth and development of young coco-palms of different fertilizers when added singly or in certain combinations to tuff soil in pots. This experiment was started on September 15, 1931 and consisted of fourteen duplicate cultures to each of which was added a single fertilizer or combination of fertilizers. The rate of application was 26.3 grams of pure fertilizing nutriments (N-P-K), the same as in experiment 3. In the case of applications where two fertilizing materials were mixed, as that of sulfate of ammonia and horse manure, the standard rate (26.3 grams) of N-P-K was equally apportioned to the two fertilizer materials, that is, 13.2 grams of

N-P-K. Where three fertilizers made up the combination, as sulfate of ammonia, superphosphate and nitrate of potash, the standard rate (26.3 grams) was again divided equally among the fertilizers making the combination. That is, 8.8 grams of whatever fertilizing nutriment or nutriments was available were supplied by each fertilizer making up the combination. On June 25, 1932, the plants were harvested.

Experiment 5: To determine again the comparative effects on the growth and development of young coco-palms of different fertilizers when applied singly or in certain combinations to tuff soil in pots.—This experiment was started on October 5, 1931, and consisted of fourteen duplicate cultures to which fertilizers were added singly or in certain combinations. On August 16, 1932, the cultures were harvested.

Experiment 6: To determine the comparative effects on the growth and development of young coco-palms of nine commercial fertilizers when added in equal amounts to tuff soil in pots. This experiment was started on September 11, 1932 and consisted of ten cultures in seven replications each. To each culture were added 457.7 grams of each of the fertilizers tested. Control cultures to which no fertilizer was added were included in the set. On January 31, 1933, the plants were harvested.

Care given to cultures

The cultures were exposed to the sun, but to protect the plants from its excessive heat during the first two or three weeks, each plant was shaded by cabo negro palm leaves. The cultures were watered and weeded from time to time; the same amount of water was given to each culture in a set.

Criteria of results

With the coco-palm, probably the best index of the effects upon the plant of fertilizers is the yield of nuts or of oil. In the present study, however, the coco-palms used were young. Hence, it became necessary to use certain criteria of results that would primarily indicate the vigor of the plants and incidentally indicate the effects of the fertilizers tried. The criteria of results employed were the following: (*a*) number of leaves produced, (*b*) length of leaf blade, (*c*) gain in height of shoot, (*d*) weight of green top, (*e*) number and weight of air-dry main roots; weight of air-dry fibrous roots, (*f*) the weight of the entire root system air-dried, (*g*) leaf product of each plant, and (*h*) green weight of entire plant.

DISCUSSION OF RESULTS

Nutritive value of Corona Cocos for young coconut palm

Although there were certain discrepancies in the data gathered in experiments 1 and 2, on the whole, Corona Cocos when used in certain amounts was able to increase the vigor and development of the plant in some of the cultures. In terms of most of the criteria of results, it seems safe to say that the development of the plant was favorably influenced materially in cultures I, II and III in which the fertilizer was present at the rates of 228.9, 457.7, and 915.4 grams per pot, respectively.

To compare the data obtained from culture II with those obtained from the control culture, the data from duplicate cultures were averaged. The results are given in the following tabulation:

CULTURE NO.	MAIN ROOTS	MAIN ROOTS	MAIN ROOTS	FIBROUS ROOTS	ROOT SYSTEM	LEAVES	LEAF BLADE	GAIN IN HEIGHT OF SHOOT	GREEN WEIGHT OF TOP
	number	*cm.*	*grams*	*grams*	*grams*	*number*	*cm.*	*cm.*	*grams*
II	21.5	1214.1	126.9	55.4	182.3	10.0	460.3	105.1	1335.3
VIII (control).	13.0	686.0	32.3	16.0	48.3	6.5	249.1	51.8	409.5
Difference, in per cent	65	77	287	246	277	54	81	103	227

The differences (in term of percentages) are decidedly in favor of culture II, and show plainly the nutritive value to young coconut plants of Corona Cocos when added to tuff soil in pots at the rate of 457.7 grams per pot. When similar computations were made to compare similar sets of data on experiment 2, the differences, although again in favor of culture II, were not as marked. These results seem, therefore, to suggest that with the limited amount of data on hand, it would be unwise to draw a definite conclusion as to the exact relative amount of benefits that the young plants were able to derive from the Corona Cocos. In accordance with the objects of this study, the data on these two experiments (1 and 2) seem to suggest that further trials of this set of cultures with more replications to the culture should test Corona Cocos at rates ranging from 228.9 to 915.4 grams to the plant if grown in tuff soil.

It may be of interest to note that the three cultures (I, II, and III) most promising for the young coconut plant contained Corona Cocos which had the following fertilizing ingredients, in *grams*:

CULTURE NO.	N	P	K	N	P_2O_5	K_2O
I	54.9	31.5	68.4	54.9	73.2	82.4
II	27.4	15.7	34.2	27.4	36.6	41.2
III	13.7	7.9	17.1	13.7	18.3	20.6

If the N-P_2O_5-K_2O contents of the tuff soil, as shown by the results of analyses made in the Department of Chemistry, were to be added to the fertilizing ingredients contributed by the fertilizer, the ratios or proportions of these ingredients in *grams* would be:

CULTURE NO.	N	P	K	N	P_2O_5	K_2O
I	94.1	89.1	184.6	94.1	207.2	222.4
II	66.6	73.4	148.6	66.6	170.6	181.2
III	52.9	65.5	131.7	52.9	152.3	160.6

It should, however, be noted that only one kind of mixed fertilizer was used in these two sets of cultures and that the ratios or proportions of N-P_2O_5-K_2O in the different cultures tested were the same, varying only in the total amounts of N-P_2O_5-K_2O used. Thus, the three promising culture media so far found were apparently the better ones only among the cultures tried, but not necessarily the best culture media for the young plants so far as the proportion of N-P_2O_5-K_2O is concerned. In other words, it might still be possible to obtain better cultures if other proportions of N-P_2O_5-K_2O were tried.

Comparative nutritive values to young coconut plant of some commercial fertilizers

The three highest records under each of the criteria of results employed on experiment 3 were arbitrarily selected and compared. It was evident that some of the fertilized culture media tried in this set produced better results, under most of the criteria employed, than the control cultures. Culture VI which contained 84 grams Ammo-Phos 13-48 and culture VII which contained 341 grams of superphosphate were probably the best in the lot, as they appear to have been the most conducive to the development of tops and of roots. In the development of the root system, however, sulfate of potash seems to be good as shown by the results obtained from culture IV. These results seem to bear out the contention of Smith and Pape (1913) that the young coconut plants are heavy consumers of potash and of phosphates.

Relatively low yields under the criteria of results employed were obtained from cultures I and II,—not because the young plants were supplied with Corona Cocos but because this fertilizer was used in these cultures only at the rate of 114.4 or 146.2 grams to a plant. In the sets of cultures previously discussed these two cultures produced also relatively low yields under the criteria of results employed.

With some alterations, the culture media in experiment 3 were again tried in experiments 4 and 5; the results showed that, on the whole, the cultures that did not receive any fertilizer were inferior to most of the other cultures, which were given fertilizers of one form or another. This finding was, of course, to be expected, and is borne out by the data under most of the criteria of results here employed. Probably the most important phase of this part of the study was to determine which fertilizers or combinations of fertilizing ingredient carriers would promote the best growth and development of the young coconut plants. But, before studying the experimental data, it should be recalled that the plan followed in the preparation of the culture media in these experiments (4 and 5) was to consider the N contents of sulfate of ammonia in culture I as the standard which was followed in the preparation of the other culture media. Bacomo (1917) found that 26.3 grams of NH_3 from ammonium sulfate when added to clay-loam soil in a newly established coconut plantation produced the most rapid growth and development of the plant.

Arbitrarily selecting the three highest yields under each of the criteria of results, cultures I, X, and XI were found to be best. These cultures may, therefore, be considered as quite promising for the young coconut plant when grown in tuff soil in pots. Of these three, probably culture X was the best. This culture contained sulfate of ammonia, horse manure, and superphosphate. Culture II which contained 114.4 grams of Corona Cocos was quite promising also, although probably better results would have been obtained if this fertilizer had been supplied to the young plant at the rates found best in previous experiments.

The following tabulation compares in term of percentage increase, the yields obtained from each of the three best cultures, (cultures I, X and XI) under the criteria of results employed, with those obtained from the control culture:

CULTURE NO.	MAIN ROOTS			WT. OF FIBROUS ROOTS	WT. OF ROOT SYSTEM	NUMBER OF LEAVES	LENGTH OF LEAF BLADE	GAIN IN HEIGHT OF SHOOT	GREEN WEIGHT OF TOP
	Number	Length	Weight						
I	40	65	44	4	19	8	26	19	62
X	64	25	85	11	43	6	22	42	91
XI	44	75	55	11	38	13	8	14	71

A similar comparison was made between each of the three arbitrarily selected best fertilized cultures and the control culture reported on experiment 5. The results, in term of percentage of the fertilized cultures over and above the non-fertilized culture (control) were the following:

CULTURE NO.	MAIN ROOTS			WT. OF FIBROUS ROOTS	WT. OF ROOT SYSTEM	NUMBER OF LEAVES	LENGTH OF LEAF BLADE	GAIN IN HEIGHT OF SHOOT	GREEN WEIGHT OF TOP
	Number	Length	Dry Weight						
I	72	93	185	72	137	33	91	150	185
X	75	104	214	112	176	40	63	184	188
XI	57	115	198	56	134	27	53	116	105

As shown by this tabulation, the selected fertilized culture media materially increased the growth and development of the young coconut plants. The data also show that, on the whole, culture X, which received 51.9 grams of sulfate of ammonia, 884.4 grams horse manure and 113.7 grams superphosphate, was probably the best of the three arbitrarily selected cultures.

It may be of interest to show the ratios or proportions in *grams*, of the following constituents that were introduced in cultures I, X, and XI by the fertilizers and manure employed:

CULTURE NO.	FERTILIZER USED		N	P	K	N	P_2O_5	K_2O
	Kind	Amount						
I	Sulfate of ammonia	155.7	26.3	—	—	26.3	—	—
X	Sulfate of ammonia Horse manure ..... Superphosphate ...	51.7 884.8 113.7	13.2	9.8	3.5	13.2	22.7	4.3
XI	Nitrate of potash .. Horse manure	142.9 1327.2	19.7	1.5	5.3	19.7	3.5	6.4

Combining the N-P-K or the N-P_2O_5-K_2O contents of the fertilizing ingredients used with the original N-P-K or the N-P_2O_5-K_2O contents of the tuff soil, the following may be of value in indicating the N-P-K or the N-P_2O_5-K_2O ratio or ratios, in *grams*, that were best in promoting growth and development of young coconut plant:

CULTURE NO.	THE N-P-K RATIO			THE N-P_2O_5-K_2O RATIO		
	N	P	K	N	P_2O_5	K_2O
I	57.1	43.3	104.6	57.1	100.8	126.0
X	44.0	53.1	108.1	44.0	123.5	130.3
XI	49.5	44.8	109.9	49.5	104.3	132.4

As was previously pointed out, culture X was probably the most promising for the plant.

Further experimental survey of the relative nutritive values of some fertilizers

To facilitate the selection of the most promising culture media tried, the three highest records under each of the criteria of results employed were arbitrarily selected. By this test it was found that cultures VI and IX were the best in the set of ten cultures, each of which was tried in seven replications. Culture IX which received 457.7 grams Corona Cocos was easily the best in the lot, better than culture VI. At this rate, this fertilizer had been previously found to be good for the young coconut plant. Culture VI, which received Ammo-Phos 20-20 at the rate of 457.7 grams per plant in tuff soil was one of the best in this lot, but when this fertilizer was used at the rate of only 104.9 grams per plant a rather unsatisfactory result was obtained. These results seem to suggest that in future experiments Ammo-Phos 20-20 should be tried in quantities around 457.7 grams to the plant in tuff soil.

The data in experiment 6 again showed the favorable influence of superphosphate and of sulfate of potash on the development of the roots of the young coconut plant. Similar results were observed from the cultures in experiment 6.

Ammo-Phos 13-48, which at the rate of 84 grams to the plant in tuff soil was found good for the young coconut plant, did not prove beneficial to the young plant, when, in this test, it was used at the rate of 457.7 grams per plant. It appears, therefore, that in future experiments, this fertilizer should be tried at the rates not exceeding 457.7 grams per plant grown in tuff soil in pots.

Data on experiment 6 also show that at the rate of 457.7 grams per plant, sulfate of ammonia or Leunaphos proved not to be beneficial to the young coconut plant. Leunaphos was for the first time tried in this set of cultures and only at this rate of application. Therefore, final judgment can not be made on its fertilizing value until smaller quantities are tried. Ammonium sulfate at the rate of 457.7 grams per plant was found to be decidedly harmful to the plant, as under some of the criteria of results employed lower data were obtained from the ammonium sulfate cultures than the corresponding data from the control cultures. Moreover, apparently better results were obtained from the ammonium sulfate cultures in previous cultures when this fertilizer was supplied to the young coconut plant in tuff soil at a much lower rate. Therefore, the harmful effects obtained from the present set of cultures, in all probability, were due to the excessive use of the fertilizer.

SUMMARY AND CONCLUSIONS

1. An experimental survey of the relative nutritive values to young coco-palms of some single and mixed fertilizers was made. Certain single and mixed fertilizers were found that may be used for more intensive fertilizer studies with this plant.

2. Of the different amounts of Corona Cocos tried, 228.8, 457.7, and 915.5 grams per pot or plant were probably the most nutritive to the young coconut palm. But, owing to certain discrepancies of results, it was not possible to choose the amount most suitable for the plant. It is suggested that further trials with this fertilizer should include amounts ranging from 228.9 to 915.4 grams or more per plant in tuff soil.

3. The culture that received 84 grams of Ammo-Phos 13-48 produced plants with well developed tops and roots, but when the application was increased to 457.7 grams per plant no beneficial effect was obtained, suggesting that the fertilizer should be tried at rates not exceeding 457.7 grams.

4. The culture that received 341 grams superphosphates per plant produced plants with well developed tops and roots. Sulfate of potash when used at the rate of 66.6 grams per plant proved beneficial to the development of the root system. These results seem to bear out the contention of Smith and Pape (1913) that young coconut plants are heavy consumers of potash and phosphates.

5. The culture that received 155.7 grams sulfate of ammonia gave good results. But, when used at the rate of 457.7 grams per

plant, ammonium sulfate was decidedly harmful to the plant. The former culture medium received 26.3 grams nitrogen (N) from the fertilizer; it had a total N-P-K ratio, in grams, of 51.7-43.3-104.6, and to total $N-P_2O_5-K_2O$ ratio, also in grams, of 57.1-100.8-126.

6. The culture that contained a mixture of 51.9 grams sulfate of ammonia, 884.8 grams horse manure and 113.7 grams superphosphate also gave good results. The N-P-K ratio from the mixture, in grams, was 13.2-9.9-3.5 and the $N-P_2O_5-K_2O$ ratio, also in grams, was 13.2-22.7-4.3. The combined N-P-K contents from the fertilizing mixture and the soil used, in grams, were 44.0-53.1-108.1; and the combined $N-P_2O_5-K_2O$ contents, also in grams, were 44.0-123.5-130.3, respectively.

7. The culture that contained a mixture of 142.9 grams nitrate of potash and 1329.3 grams horse manure also gave good growth and development of the young coconut plants. This culture medium received from the mixture 19.7 grams N, 1.5 grams P, and 19.7 grams K. It also received from the mixture 19.7 grams N, 3.5 grams P_2O_5, and 6.4 grams K_2O. When the fertilizing ingredients from the mixture and from the soil were combined, this culture medium contained 49.5 grams N, 44.8 grams P, and 108.9 grams K; the $N-P_2O_5-K_2O$ contents, in grams, were 49.5-104.3-132.4.

8. Ammo-Phos 20-20 fertilizer when used at the rate of 457.7 grams per plant proved to be one of the best mixed fertilizers so far tried for the young coconut plants. But this was the highest amount tried. Thus, in future experiments Ammo-Phos 20-20 should be tried in quantities around 457.7 grams per plant in tuff soil.

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E. GERTRUDE MADISON: IN MEMORIAM[1]

It is with profound sorrow that we record the death of Professor E. Gertrude Madison on March 2, 1935 in Waynesburg, Pennsylvania.

Professor Madison was on our English staff from June, 1923 to April, 1925. Since leaving the College she has been head of the Department of English and Dean of Women in Waynesburg College, Waynesburg, Pennsylvania. Death found her where Life had always found her, at her post giving of her best—a service that was of superior quality.

In this College and on all students with whom she came in contact she left a deep and lasting impression. As a teacher, that is as an imparter of knowledge and developer of mentality, she was in many respects exceptional in ability and skill. As a personal influence, she was strong and fine. She gave of herself fully and freely and as she was a woman of real culture, integrity of the highest, with lofty ideals and true, what she had to give was precious even as Mary's ointment of spikenard.

The two years Miss Madison was with us was a time when the department was making special effort to lay a foundation for work outside that of the curriculum which it was hoped would be of permanent value. In her cordial giving of her experience and culture Miss Madison's aid was invaluable. She started the College Sing. She presented the first work in dramatics when we had not even the beginnings of a stage, or curtain of any kind. What plans, what visions we had! And with what sympathetic interest she always wrote of what I could report on these and other activities in the years after she returned to the homeland. A student once said to me: "Professor Madison brought joy and singing to the Campus". A remark which it gave me much gratification to pass on to Miss Madison.

That this same spirit of eagerness in bringing the best in culture to students was a real part of Miss Madison's character, the following from the Waynesburg *Messenger,* a daily newspaper (under date, March 2, 1935), reveals: "Ever interested in the advancement of art and music Miss Madison directed the Waynesburg Lecture Course

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[1] General contribution from College of Agriculture No. 495.

Bureau for the past several years. She was instrumental in improving the College Library and in bringing nationally known musicians and lecturers to the community.... She was considered an outstanding educator and the many hundreds of students who have sat under her in the classroom since she joined the college faculty have expressed their praise of her disposition and their gratitude for the inspiration they received from her classes and her counsels."

College of Agriculture students throughout the Islands who were so fortunate as to have known Professor Madison will add their expressions of gratitude to those of the Waynesburg students and also those of Cornell College, Mount Vernon, Iowa where Miss Madison had taught before coming to the Philippines. And our faculty know that the world is poorer because Miss Madison has gone to her "long home".

With the Waynesburg College paper we know that though: "A true friend has left us, a spirit of courage, of loyalty, of honor, of love remains."

EMMA S. YULE
Of the Department of English

Oh, may I join the choir invisible
Of those immortal dead who live again
In minds made better by their presence; live
In pulses stirred to generosity,
In deeds of daring rectitude; in scorn
For miserable aims that end with self,
In thoughts sublime that pierce the night like stars,
And with their mild persistence urge man's search
to vaster issues!—GEORGE ELIOT

(*From Dean Baker's Scrap Book*)

ABSTRACT[1]

Farm ownership and tenancy in eight selected municipalities of Bohol. DIOSDADO BONGATO. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 454; Experiment Station contribution No. 1036.*) —The author made a survey of eight selected municipalities of Bohol: namely, Balilihan, Bilar, Carmen, Clarin, Guindulman, Jagna, Tubigon, and Ubay, to study farm ownership and tenancy. There were 385 farms surveyed in the study of farm ownership, the minimum number was in Ubay (16) and the maximum in Jagna (81). Of the 385 farm operators, 372 were sons of farmers, and 13 were non-farmers' sons. The ages of separation from father varied from 19.6 years to 21.5, and the average was 20.7 years; 6.2 years later or at the average age of 26.9 years, the sons acquired their farms. The average area of the present farm is 5 hectares, which showed an increase over the area of the first farm owned the area of which averages 1.7 hectares.

Farm acquisition by purchase formed the highest percentage, 42.1; 38.4 per cent was by inheritance; 11.8 per cent, by homestead, and 7 per cent, by marriage. In the case of farmer's sons, most of the farms were acquired by climbing the agricultural ladder consisting of three rungs· Farm boy, Tenant and Ownership. Among non-farmers' sons, farm acquisition was negligible.

There were 201 tenants surveyed in the eight municipalities. The smallest number was in Ubay and the largest in Tubigon. The ages at separation from the father did not vary much; the average was 21.4 years. The ages at the time of the survey had but very slight variation; the average was 33.1 years. The average area cultivated was 1.5 hectares. It was found that most of the tenants are related to the landlords, forming 62.2 per cent, in part offsetting permanency, which in tenancy is undesirable. Landlords generally reside in the same barrio where their farms are located.

Contracts are verbal and follow the custom of the locality. The duration is uncertain, and the common crops grown are cereals. Three types were found, the difference lies only in the capital: the seeds and work animals may or may not be furnished by the landlord. In all cases the net product is equally divided.

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[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

The majority of the tenants, that is 63.7 per cent, got their experience with their fathers. Tenants from other businesses formed a percentage of 15.9.

Abstract by S. T. Pagcaliwagan

CURRENT NOTES

The reasons for Japan being able to produce goods at a cheaper rate than any other country (according to Mr. A. R. Pears the Ex-General Secretary of the *International Cotton Federation*) are:

1. Low overhead charges. Salaries of all office workers, mill managers are only a third and less of what one pays in England. Rents and taxes are cheap.....

2. Eighty-five per cent of the mill operatives are girls. They are paid at the rate of approximately a shilling a day of 8½ hours. There is no old age pension, sickness insurance but the mills maintain for the sake of workers theatres, cinemas, schools, gymnasiums, hospitals.

3. The Japanese are shrewd businessmen, painstaking, hardworking, quick in making decisions, ready to pick up a new variety of cotton or new machine. They keep their machinery up to date, quickly replacing worn out parts. They are past masters in mixing cotton. The mills are cleaner than any mills in Asia and most mills in Europe using Indian cotton.

The Madras Agricultural Journal, February, 1935

The sugar contained in fruit and honey is just as Nature provides it and is in conjunction with certain acids and mineral salts which the body requires.

Chemically, there are three principal sugars contained in honey:—cane sugar (sucrose), grape sugar (dextrose), and fruit sugar (levulose), the last two together being called "invert sugar"—that in plain words mean that it has been inverted or changed. Cane sugar (sucrose) requires to be changed before it can be used by the human body; invert sugar has been changed and is ready for assimilation by the blood stream almost immediately it has been passed into the stomach. The sugar on our breakfast and tea tables is pure sucrose and must be acted upon by the secretions of the stomach and inverted before it can be passed into the blood stream.

Honey contains less than 2 per cent of sucrose, and often practically none, and from 75 per cent to 85 per cent of invert sugar. It will thus be realized that the sugar in honey requires practically no effort to digest and the human body obtains the full benefit of the carbohydrate food....

Another important value of honey is its inability to carry germs of any disease that attack the human frame, being self sterilizing. The reason for this is that it is hygroscopic, that is to say, it attracts moisture to itself. All life contains water, even the smallest disease germ contains moisture, and if this is removed, it dies. Any germ, therefore, that may find its way into honey is destroyed by having its moisture taken from it by the honey. This is an important fact, which it is not believed applies to any other food.

Queensland Agricultural Journal, August, 1934.

At least 75 per cent of the total annual production of rubber is absorbed by the automobile industry. Each private motor car fitted with the new upholstery will require an additional 20 to 30 lb. of rubber, exclusive of the tires. This represents an increase of 75 per cent. Each single deck 'bus will use about 120 lb. of the new rubber upholstery.

Tropical Life, August-September, 1934.

Coconut oil and palm kernel oil are principally used for the manufacture of margarine and soap, while glycerine is an important by-product. In the United States, prior to the imposition of the new processing tax, from 55 to 60 per cent of the total consumption of these oils entered into soap, 25 to 30 per cent into margarine and from 10 to 15 per cent into other food.

Palm oil is used mainly in soap making, but an important addition is its use as a flux in the manufacture of tin plate, for which purpose nearly 7,000 tons were consumed annually in the United States. It is also used to a minor degree in margarine making.

Coconut oil is used in the margarine industry as a principal ingredient of vegetable oil margarine and no other oil which has been tried on a commercial scale has proved as satisfactory in making this type of margarine. In the United States, vegetable oil margarine is practically exclusively manufactured; elsewhere than in the United States, however, vegetable oils used in margarine manufacture have suffered from the severe competition of whale oil since, in Europe, hardened and refined whale oil is a major constituent of margarine.

Whale oil production is now in the region of 350,000 tons per annum. The increase is due primarily to the exploitation of the Antarctic waters and to modern methods of whale catching. Norway produces about half the world supply of whale oil, and Great Britain and British Possessions produce the next largest quantity.

The production of soya bean oil has also greatly increased of recent years and it has become a serious competitor with coconut oil in margarine making in Europe. The chief supplies are derived from Manchuria.

Before the art of refining, deodorising and hardening oils was as well understood as at present, some difficulty was experienced in utilizing whale and soya bean oils, but now, taste and smell can be completely removed and a hard fat can be obtained.

The Malayan Agricultural Journal, September, 1934.

COLLEGE AND ALUMNI NOTES

On the evening of April 30, Dr. E. B. Copeland, Founder and First Dean of the College of Agriculture was honor guest at a dinner given by the faculties of the School of Forestry and College of Agriculture at Molawin Hall. This was a farewell dinner to Doctor Copeland who sailed for the United States on May 15. Doctor Copeland has accomplished the work for which the Bureau of Plant Industry invited him, as an agricultural expert, to return in 1932 to the Islands to do. He has established the Economic Garden at Los Baños on the site of what in past years was a U. S. A. Post, Camp Eldridge.

At the dinner, Prof. Placido Dacanay spoke for the School of Forestry and Dean Gonzalez for the College of Agriculture. Doctor Copeland, in his own individual manner with a semi-humorous semi-technical introduction gave his good bye words of counsel in the frank sincere manner that he was wont to use in the days when he was at the helm. With not many exceptions those at the table had been started on their careers under his personal tutelage. During the three years he has been at Los Baños, as Dean Gonzalez said, he has been a mentor always ready when asked to give of his experience and wisdom. All present wish Doctor Copeland God Speed and hope that one of Life's turn of the wheel will send him back again.

Dean and Mrs. B. M. Gonzalez, Dr. F. M. Fronda, Dr. L. G. Gonzalez, and Dr. M. Manresa were members of the party headed by Secretary Jose Yulo of the Department of Justice and Director Paulino Santos of the Bureau of Prisons which made an inspection trip in Mindanao and Palawan from April 12 to 22. The party inspected the penal colonies of the Bureau of Prisons in Iwahig, in Davao, and in San Ramon. The College section of the party report that the agricultural development work of the Bureau of Prisons has improved greatly. They were particularly happy to see the Los Baños Cantonese chickens and the Berkjala pigs performing admirably.

The agricultural work of the Bureau of Prisons is now largely in the hands of alumni of this College. In Iwahig, Mr. Pedro S. Paje, '27, who is the Second Assistant Superintendent of the Colony, heads the list of Aggie alumni; in Davao, Mr. F. B. Santos, '18, is the Assistant Superintendent; and in San Ramon, Mr. Severo G. Yap, '21, is the Assistant Superintendent. The other alumni of the College who are in charge of the different agricultural projects of the Bureau of Prisons are:

In Iwahig Penal Colony: Mr. Candido Bagaoisan, '30, is in charge of the industrial projects of the Colony; Mr. Felix F. Villa, '28, is in charge of poultry raising; and Mr. Claudio Arellano, '30, of cattle raising. Mr. Arellano is stationed in Inagawan, so is much isolated from the Colony proper. He is living alone with the colonists, and has acquired the high sounding title of *SULTAN OF INAGAWAN.*

In Davao Penal Colony: Mr. Pascual Robin, '27, is in charge of horticulture, assisted by Mr. Herminio Espino, '29; and Mr. Daniel F. Asuncion, '29, is in charge of rice culture. Mr. Teofilo Rivera, '35, is doing his best to produce pork for the Colony, and Mr. Andres F. Nono, '32, is in charge of malaria control. Mr. Nono is detailed temporarily in Davao from Iwahig.

Messrs. Felixberto Relova, '29, and Isabelo Monje, '33, are both employees of the Bureau of Plant Industry with special assignment in Davao Penal Colony. Mr. Relova is working on pomology, and Mr. Monje on tobacco.

In San Ramon Prison and Penal Colony: Mr. Valentin Amon, '30, is the poultry supervisor for the Bureau of Prisons. He is in charge of the poultry development work of the Colony; they plan to develop a 30,000-hen farm. Mr. Tranquilino V. San Pedro, '33, is in charge of dairy and range cattle, and of swine. Mr. Venancio Garcia, '33, is the horticulturist of the Colony, and Mr. Simeon Estocapio, '35, is in charge of general farming.

The other alumni of the College whom the inspecting professors had a chance to meet on this trip are:

Mr. Valentin Macasaet, '18, is residing in Puerto Princesa. Mr. Macasaet is now owner of a transportation business in "Puerto" and is also engaged in general farming.

Mr. Fernando D. Luistro, '15, is the district agronomist of the Bureau of Plant Industry with headquarters in Cotabato, Cotabato. Mr. Luistro was with the party when they were in Davao Penal Colony.

Mr. Bonifacio Padilla, '22, is with the Bureau of Plant Industry with station in Davao, Davao. He said that, Messrs. Pastor Villanueva, '34, and Jose Santiago, '34, are working with him in the office of the District Agronomist in Davao.

Mr. Paulino Menor, '26, started working for the Furukawa Plantation in Davao soon after his graduation from the College. He is still connected with this Company, holding a responsible position.

Mr. Isidoro R. Collado, '20, is general agent in Davao, Davao. He intends to settle in the province and engage in general farming. Incidentally, friends of Mr. Collado will be pleased to hear that a pair of husky twins recently arrived in his family.

While on the Bureau of Prisons inspection trip Dean Gonzalez left the party the last two days to go to Negros Occidental to look over some property for the Philippine National Bank. This brought Dean and Mrs. Gonzalez to Negros on Saturday, April 20. On Sunday, April 21, Dr. and Mrs. Alexander Gordon (Dr. Gordon belongs to Class 1923) showed them around the property of La Carlota Central. Afterwards, Doctor and Mrs. Gordon honored them with a tea to which they invited all the Aggie alumni in the locality. Among those present were Mr. Julian Gomeri, '31; Mr. Melquiades Medina, '21; Mr. Genaro S. Layug, '32; Mr. Salvador Aldaba, '24; Mr. Loreto Valera, '32; Mr. Domingo Regner, '33; Mr. Juan B. Cabanos, '19; and Mr. Catalino Buligan, '28.

The summer recess activities this year on the Campus included the Fourth Rural Life Institute, First Alumni Faculty Conference, Extension Courses in poultry and plant propagation and the Summer School. The Rural Life Institute and the Faculty Conference were combined with the title First Alumni Institute. Each lasted one week.

In the Fourth Rural Life Institute the work followed that of the three previous years. Efforts were made to make the lectures and demonstrations non-technical in language. The enrollment was 28 from 14 provinces and represented 6 religious denominations.

The First Faculty Conference was well attended by the members of faculty on the Campus and by some students. One alumnus—Mr. Gaudencio Reyes '20, now plant pathologist in the Bureau of Science honored the Conference, by attending several days. During the Conference twelve talks were given by faculty members.

The Eleventh Graduation Exercises of the Extension Classes of the College of Agriculture were held on Saturday, May 18. Of the 79 certificates that were awarded, 57 were in poultry raising, and 22 in plant propagation. Ten of those who received certificates in poultry raising were women. The opening remarks were by Dr. F. M. Fronda and Dean B. M. Gonzalez distributed the certificates and addressed the graduates.

It is of interest to note that about 45 per cent of the extension students this year are teachers and about 15 per cent are farmers. The members of the extension classes came from 26 provinces. They ranged in age from 18 to 48 years old. The majority of them had completed the high school and some more advanced courses and 11 were holders of a university diploma.

The Summer Session closed on Saturday, May 18. The registration was 206 regular students of whom 2 were women. Last year, only 181 Summer students registered.

Mr. Anastasio A. Rowan '23 was a recent Campus visitor. He was especially interested in the coffee and cacao plantations and bought coffee seeds for planting. He also conferred with Prof. V. B. Aragon about varieties of rice to plant in Bañga, Capiz. He bought some rice seeds for planting purposes.

When leaving he said: "It is a real pleasure to be back and refresh the memories of the past. I have gone all over the Campus, the Experiment Station ground and the Forestry School, and am deeply impressed with the improvement of the roads, buildings and teaching aids found in both institutions. If the present students have anything to complain of it should be the lack of hardships which developed the resourcefulness and strengthened the stamina of the former students. I appreciate the courtesy extended to me. My only regret is that I cannot stay longer and meet all my old professors."

Mr. Julian Jamais '20, of Castillejos, Zambales and Mr. F. W. Maage visited the Department of Agronomy on May 10. They are interested in cassava culture and cassava starch manufacture. Mr. Jamais is a farmer and in addition to rice is planning to plant cassava on a relatively large scale. He is assured of manufacture of his crop as Mr. Maage has a cassava factory in Castellejos and Mr. Jamais is associated with him.

The recent Sakdalista uprisings once more proved that the "Los Baños Spirit" is still very strong on the Campus. Members of the faculty, employees, and students volunteered to take their turn in guarding the College Campus at night from May 2 to May 14, all for the sake of peace and public order in the community. This spirit brought up memories of the wholesale enlistment of College in National Guard in 1918.

Charles Darwin, looking back in his 70th year, said:

"If I had my life to live over again, I would make it a rule to read some poetry and listen to some music at least once every week; for perhaps the parts of my brain now atrophied would thus have been kept alive through use. The loss of these tastes is a loss of happiness."—AUGUSTUS THOMAS.

The Readers' Digest April, 1935.

Condemnation is interesting, construction is a bore.

WILL DURANT

ORIGIN OF CULTIVATED PLANTS [1]

The subject I am going to talk to you about this evening is based on a translation from the Russian Bulletin on the origin of cultivated plants, as seen through the eyes of the Soviet Union. This subject I regard as one of the most interesting experiments in plant breeding, giving entirely a new footing to current ideas. In the old days, in improving cultivated plants geneticists were dealing with material, which attained a limit of improvement rapidly and which therefore did not provide scope for further improvements. Their going to near and related wild species to improve cultivated crops frequently led to disappointment and failure. Professor Vavilov of Russia propounded an entirely new view of the origin of cultivated plants which opened out methods to the breeder for the improvement of his crops. His principle is not altogether new nor unknown to botanists. In Ceylon, Willis, a worker of international fame on plant distribution has covered very much the same ground. Professor Vavilov started collecting material from all over the world with the object of saying in what parts and where richest material for breeding work could be found. His evidence tended to show that varieties distribute themselves in a definite and regular zonation. He found certain places where the wealth of plant material was richest in concentration; for example, in Afghanistan, wheats of all possible types were found, including even new species unknown to science. Moreover, the new species were all found to be concentrated in a limited area near the foot of the hills, mountainous regions being an intensively rich source of new material. He also found that in passing outward from the centre of concentration, wealth of forms and types gradually reducing and falling off towards the peripheral area, where only one, two or three types were present, while the inner centre contained more than a thousand different types. Another interesting observation was that the centres were characterised by other factors, viz., predominance of dominant factors usually associated with primitive wild types which as one reached the periphery reduced itself giving place to the recessive ones. He also found that these centres have no relation to regions where related wild species are found. For example, wheat which was so rich in Afghanistan was not found anywhere else, the nearest spot where it was found being Mesopotamia. It was thus proved that the earlier geneticists were entirely wrong in dealing with those wild types which were certainly not the ancestors of the crops they had to improve.

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[1] By Dr. P. S. Hudson, B. Sc., Ph.D. (Cantab), Dy. Director, Imperial Bureau of Plant Genetics, Cambridge. Extracted from the "Proceedings of the Association of Economic Biologists, Coimbatore", Vol. I, 1930-1933. Reprinted in *Tropical Agriculturist* (Ceylon) February, 1935.

Carrying on the observations to other plants it soon became evident that a similar state of affairs to what we found in the case of wheat existed with all plants; and from further study it emerged that there was no definite and independent centre for each individual crop, but there were some limited centres for groups of plants. According to Professor Vavilov there are five such centres in the world as follows:

1. South-western Asia . . . Parts of Afghanistan, Mesopotamia,
2. South-eastern Asia . . . . The East Indian Archipelago,
3. The Mediterranean region,
4. North-east Africa . . . . Abyssinia,
5. Central and Southern America.

The above five are the sources of the world's cultivated plants, and these plants as we now know them have originated from these centres and diffused naturally or through artificial agencies and filled the world. It is obvious therefore that if we want new forms to improve our crops these are the places to search for them.

The reason why cultivated plants should have this origin is still open to speculation. Professor Vavilov emphasised that these regions were also the centres of ancient civilisation and agricultural population in the past. The two are somehow correlated. Whether these spots became rich in plant material on account of the population or whether the richness of the material induced colonisation, it is difficult to say. Yet another interesting feature is that these zones, excepting perhaps the Mediterranean, are mountainous, tropical and sub-tropical regions. Probably these mountains and the prevailing climatic conditions were favourable to plant variation, and mutations were more frequent. Chromosome irregularities characteristic of the peculiarities of climate probably got connected.

While, therefore, the actual process of origin of these plants is a question of conjecture, it is interesting to observe the stages of domestication. In some plants this is very easy to follow. The potato for example exists in a large number of different forms in South and Central America. The potato of Europe and Asia show very little variation. But in South America the species exists not only in greater forms, but also in specimens of different chromosome numbers and with highly desirable qualities which the potato breeder is after. In one fertile area it is possible to find all stages of domestication of this plant. On the hillsides we find the wild type without tubers at all; then we have the type with tiny tubers which are not however of any economic importance; then we have others with tubers of some size which enterprising people collect and use for planting near their houses, and then we come to the types which are more advanced and finally to those which are the result of selection. It is possible to trace through all the stages from the wild to the cultivated.

In many plants it is also possible to trace quite frequently and realise how the plant has developed itself in independent zones. So we cannot speak of one phase of origin. Local cultivation of the different innumerable types must have resulted in a series of cultivated groups entirely independent, sometimes related, in others different, depending on cultivation practices.

In the case of certain plants no wild forms can be traced even if we search the whole world over. This applies to ancient crops like the cultivated cereals and we are forced to conclude that no wild species ever existed. In other words, the plant arose into cultivation by two distantly related wild species crossing with each other and bringing about a new species, probably with chromosome doubling and the disappearance of the sterile characters. In substantiation of the above theory it can be stated that many ancient crops, wheat for example, exist in a number of different forms with different chromosome numbers. The variety known as the soft wheat cultivated in Central Asia and Turkestan has 42 chromosomes, while that grown in Afghanistan has only 28 and is apparently unrelated. We are forced to conclude that these originated independently with different parental species. In cotton we find a similar thing. The American cotton found in South America is different from the Asiatic one in Afghanistan and owes its origin to different ancestors.

These several observations of Professor Vavilov must therefore be a lesson to plant breeders who may have to entirely revise their scheme of work as a result of these observations. This leads us to the undertaking of the creation of new forms of plant life. If in the course of centuries, Nature has been able to give us these forms, in the twentieth century, the question arises, what, understanding this working of Nature, we may not be able to do, to produce probably new and hitherto unknown cereals, fruits, vegetables, etc.

ALCOHOL AND ALCOHOL-GASOLINE BLENDS AS FUELS FOR AUTOMOTIVE ENGINES: I. PERFORMANCE TESTS OF NEARLY STRAIGHT ALCOHOL OF DIFFERENT GRADES USING A SIX-CYLINDER AUTOMOBILE ENGINE [1]

A. L. TEODORO
Of the Department of Agricultural Engineering

WITH ONE TEXT FIGURE AND NINE CHARTS

The use of alcohol and of alcohol-gasoline blends as a substitute fuel for gasoline has been found satisfactory for stationary and for traction engines. The writer presents in a series of articles, of which this is the first, quantitative results which may aid in determining the possibility of utilizing alcohol as fuel for trucks and for automobile engines in the Philippines. Bench tests were carried out to study the adaptability of different grades of nearly straight alcohol for new models of motor vehicles like the Chevrolet, Waukesha motor and Ford V-8. These makes were selected because of the differences of the compression ratio of their prime movers and of their popularity in the Islands for transportation purposes.

The Bureau of Agricultural Engineering of the United States Department of Agriculture [2] conducted field and laboratory tests in tractors and trucks to compare performance characteristics of alcohol-gasoline fuel blends. Gasoline mixed with 10, 20, and 30 per cent absolute alcohol was used. The results of the test were favorable to the use of alcohol-gasoline blends for the following reasons: (1) Mileage was practically the same; (2) there was more carbon found in the head of the engine that used plain gasoline; and, (3) greater power on alcohol than on gasoline was developed when high altitude pistons were used. The present investigation considers the factors of economy and of performance when nearly straight alcohol was used as fuel.

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[1] Experiment Station contribution No. 1038. Received for publication April 12, 1935.

The engine used in these tests was Chevrolet (Independence model).

[2] Report presented at a session of the Power and Machinery Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society at Purdue University, Lafayette, Indiana, June, 1933. A contribution of the Committee on Agricultural Engine Research. Presented by R. B. Gray, Chief, division of mechanical equipment, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. A.S.A.E.

1933. Performance tests of alcohol-gasoline blends. Agricultural Engineering 14: No. 7.

The Calamba Sugar Estate lent the Chevrolet engine used and supplied gratis almost all the fuels and oils consumed. C-blended fuel No. 2 was given free by the Central Azucarera de Tarlac. The Ford V-8 was lent by the Manila Trading and Supply Co. The Waukesha Motor Works, Waukesha, Wisconsin, U. S. A., gave gratis to the Department of Agricultural Engineering, the Waukesha engine. Many of the accessories used were provided without charge by the Calamba Sugar Estate and some were lent by the International Harvester Company of Philippines.

The work was carried out by the writer for over eight months in the testing laboratory of the Department of Agricultural Engineering, College of Agriculture, University of the Philippines with the assistance of Jose Coronel and of Pedro Barrameda, both of Calamba Sugar Estate. Three other men from the same Estate helped in the tests for over a month. Jesus P. Mamisao of the Department of Engineering determined the oil dilution, carbon deposit, and piston ring wear, and prepared all the graphs in final form. Arturo Ferriols and S. R. Cruz also of the Engineering Department aided in overhauling the engines and in recording the observed results.

GROUPS OF TESTS

Three groups of tests I, II, and III were made. All the tests in the Chevrolet were grouped under I, all tests in Waukesha engine under II, and those in Ford V-8, under III. The objects of the tests, the materials and procedures, and the results and discussions for each group are given separately.

The specifications of the engines are given in table 1.

Group I: Chevrolet

Two series of tests, A and B, were performed under this group. In series A, a comparative study between gasoline, C-blended fuel No. 2, and different grades of A-alcohol motor fuel was made with the use of up-draft and with down-draft carburetors. The tests were run under variable loads and speeds. Four fuels were used with up-draft carburetors and eight with down-draft carburetors. In series B, only three fuels were used. The engine wear, crankcase oil dilution, oil consumption, and carbon deposit were determined in this series.

Each test in series A was considered complete when it included the determination at different speeds of: (1) maximum brake horsepower; and (2) fuel economy at maximum, at ¾, at ½, and ¼ maximum brake horsepower at each of the speeds. The maximum torque was determined during the maximum brake horsepower run at speeds of 2000, 1800, 1600, 1400, 1200, 1000, 800, 600, and 400 r.p.m. For runs at ¾, ½, and ¼ maximum brake horsepower, at the same speed, the torque was set at ¾, ½, and ¼, the maximum for this speed, by making proper throttle setting for such load. From these determinations preliminary curves were plotted to show the relation between torque, speed, horsepower and fuel economy. The engine was controlled by means of throttle, only. After the size of the carburetor jets was changed to admit enough fuel to obtain the best brake horsepower output, no further adjustments were made during the test. The time of sparking for all alcohol fuels was kept the same as that found best suited for gasoline.

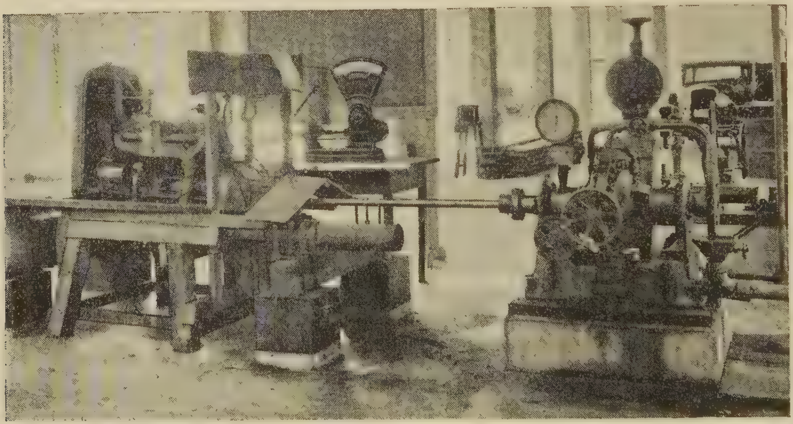

Fig. 1.—Chevrolet engine being tested on the block.

Before beginning any test the engine was run-in for about 30 minutes. Readings were not taken until the engine was brought to a condition of sustained operation. The valves were carefully timed prior to testing a new fuel. Enough runs were taken throughout the speed range so that the points, when plotted, indicated clearly the shape and characteristics of the curves. The brake horsepower and fuel economy tests for each load lasted for a minimum period of six minutes. The procedures followed in balancing the dynamometer, taking fuel consumption, and in recording speeds and temperature were the same as those followed by Teodoro and Banzon[3] in their alcohol fuel investigation.

In series B, the engine was overhauled before and after each fuel test. The method used for determining the carbon deposit, piston rings wear, oil consumption, oil viscosity, and oil dilution were also the same as those followed by Teodoro and Banzon. Engine adjustments were made for the best power output. The ignition

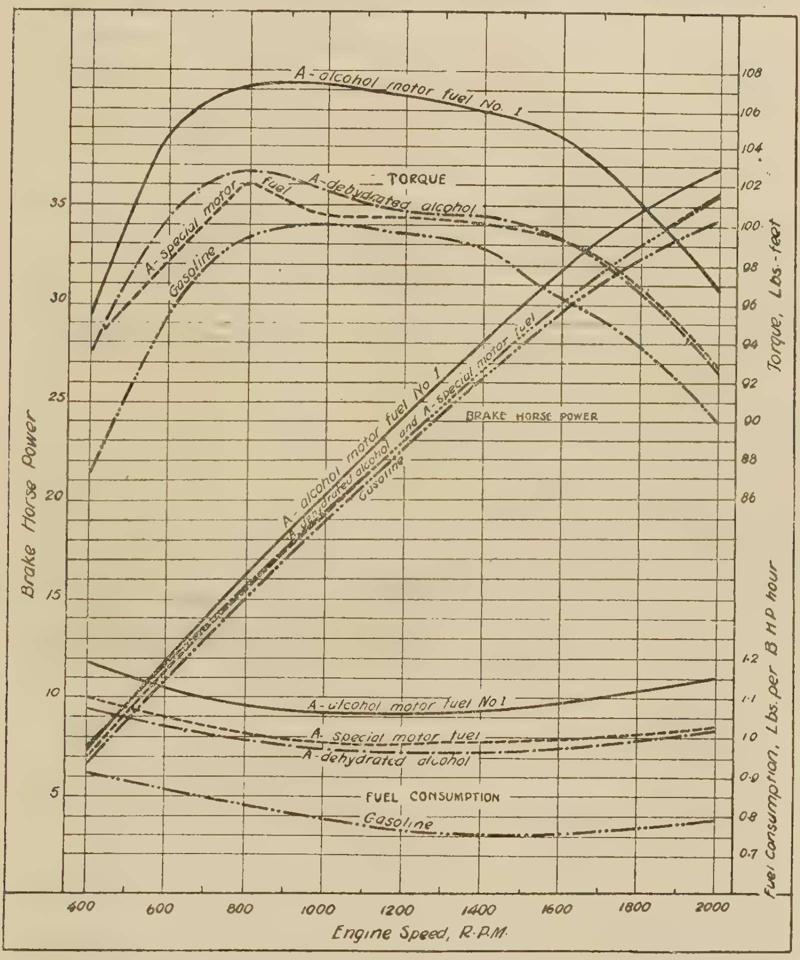

Chart 1.—Performance curves of Chevrolet engine using up-draft carburetor. Full load.

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[3] TEODORO, A. L., AND J. BANZON. 1932. Tractor engine tests using gasanol, gastarla, pure kerosene, and mixtures of pure kerosene and crude oil as fuels. The Philippine Agriculturist 21: 370–413.

timing was changed so as to give the most efficient performance for each kind of fuel tested. A continuous 10-hour run was made for one day for each fuel at 2000 r.p.m. using the maximum torque obtainable with full throttle. To complete the test another continuous run of 6½ hours duration was made on another day also at full throttle but at a speed interval of approximately 200 r.p.m.

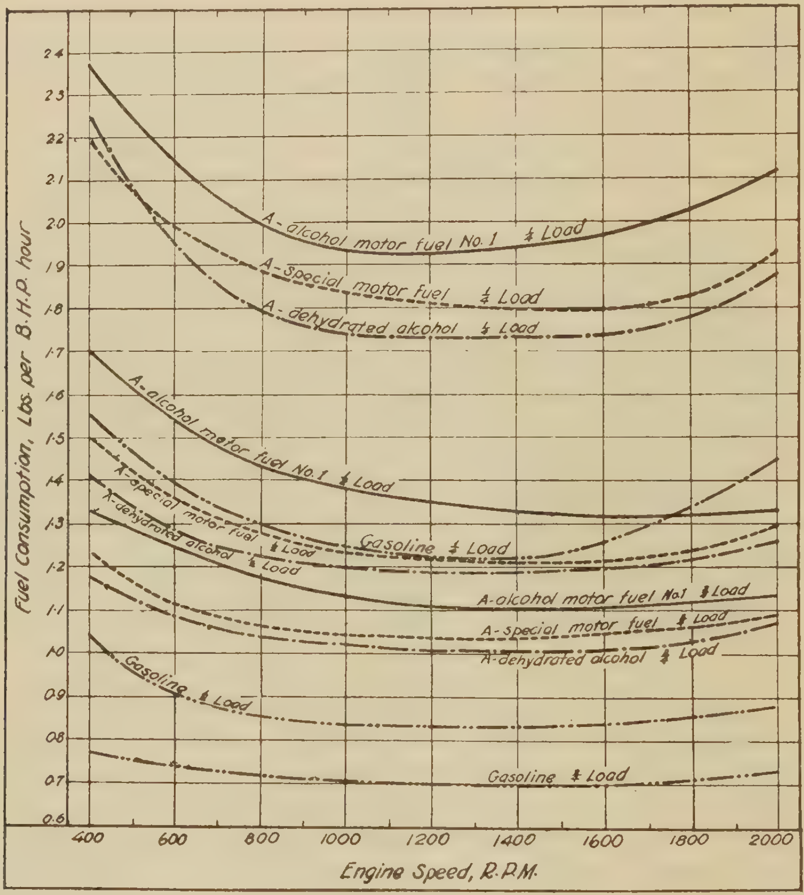

Chart 2.—Fuel economy curves at 3/4, 1/2, and 1/4 loads. Chevrolet engine with up-draft carburetor.

The fuels used with up-draft carburetors were as follows:

1. A-alcohol motor fuel No. 1. One gallon = 6.7375 pounds at 15°C. Constituents by volume.

Alcohol (95 per cent by volume)	99.00 per cent
Gasoline	0.50 "
Aniline	0.50
	100.00

2. A-dehydrated alcohol. One gallon = 6.5515 pounds at 15°C. Constituents by volume.

Alcohol (99.6 per cent by volume)	99.00	per cent
Gasoline	0.50	" "
Aniline	0.50	" "
	100.00	

3. A-special motor fuel. One gallon = 6.6565 pounds at 15°C. Constituents by weight.

A-dehydrated alcohol	1.0 part
A-alcohol motor fuel No. 1	1.21 parts

4. Gasoline. One gallon = 6.1542 pounds at 15°C.

The fuels that were used with down-draft carburetors were as follows:

1. A-alcohol motor fuel No. 2.[4] One gallon = 6.6832 pounds at 15°C. Constituents by volume.

Alcohol (94 to 95 per cent by volume)	99.00	per cent
Gasoline	0.50	" "
Aniline	0.50	" "
	100.00	" "

2. A-alcohol motor fuel No. 3. One gallon = 6.6448 pounds at 15°C. Constituents by volume.

A-alcohol motor fuel No. 2	2 parts
A-dehydrated alcohol	1 part

3. A-alcohol motor fuel No. 4. One gallon = 6.5882 pounds at 15°C. Constituents by volume.

A-dehydrated alcohol	1 part
A-alcohol motor fuel No. 2	1 "

4. C-blended fuel No. 2. One gallon = 6.5149 pounds at 15°C. Constituents by volume.

Alcohol	60.00	per cent
Gasoline	35.00	" "
Benzol	5.00	" "
	100.00	" "

5. A-alcohol motor fuel No. 5. One gallon = 6.6757 pounds at 15°C. Constituents by volume.

A-dehydrated alcohol	1 part
A-alcohol motor fuel No. 2	1.21 parts

6. A-alcohol motor fuel No. 6. One gallon = 6.5882 pounds at 15°C. Constituents by volume.

A-alcohol motor fuel No. 2	1 part
A-dehydrated alcohol	2 parts

7. A-dehydrated alcohol.
8. Gasoline.

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[4] A-alcohol motor fuel Nos. 1 and 2 differ slightly in the strength of straight alcohol used.

In series B, the fuels used were A-alcohol motor fuel No. 1, B-dehydrated alcohol, and gasoline.

Results and discussion. The results of tests using the regular up-draft carburetor are shown in tables 2, 3, 4, 5 and in charts 1, 2, 3. The following points were clearly indicated:

1. That the torque and consequently the brake horsepower developed at 2000 r.p.m. was larger using A-alcohol motor fuel No. 1 than with the other fuels. A maximum difference of approximately 6 per cent in torque and about 4 per cent in brake horsepower was obtained. The maximum torque for all fuels appeared at about 800 r.p.m.

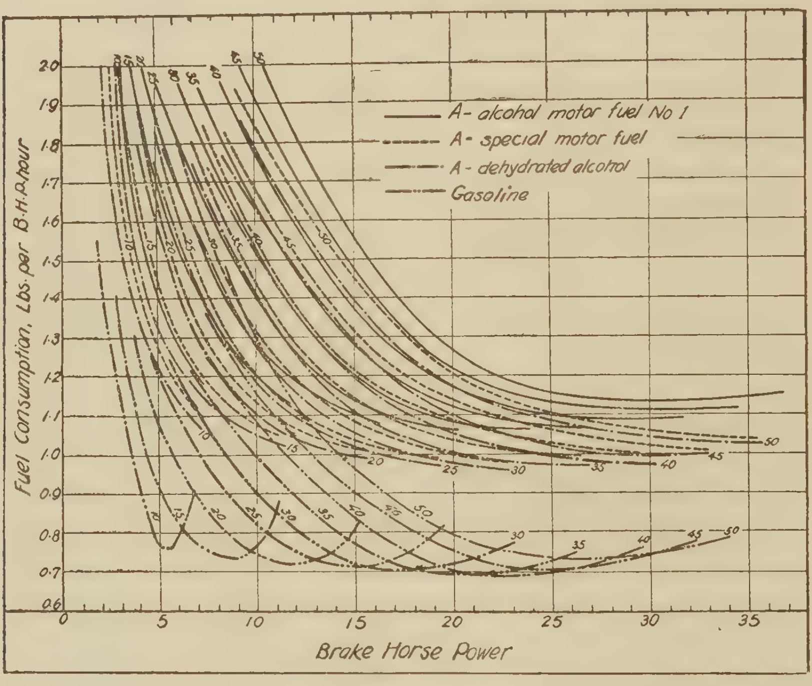

Chart 3.—Relation between fuel consumption and horsepower at different engine speeds. Chevrolet engine with up-draft carburetor. Engine speed expressed in kilometers an hour (speedometer reading).

2. That the most economical consumption at full throttle in pounds per brake horsepower hour was approximately as follows:

a. 0.750 for gasoline at 1400 r.p.m.
b. 0.959 for A-special motor fuel at 1200 r.p.m.
c. 0.980 for A-dehydrated alcohol at 1000 r.p.m.
d. 1.059 for A-alcohol motor fuel No. 1 at 1000 r.p.m.

3. That by throttling at fractional loads the fuel economy expressed in pounds per brake horsepower hour as taken from the curves was as follows:

FUEL	3/4 LOAD	1/2 LOAD	1/4 LOAD
Gasoline	0.692	0.830	1.219
A-special motor alcohol	1.010	1.181	1.725
A-dehydrated alcohol	1.030	1.210	1.790
A-alcohol motor fuel No. 1	1.100	1.319	1.929

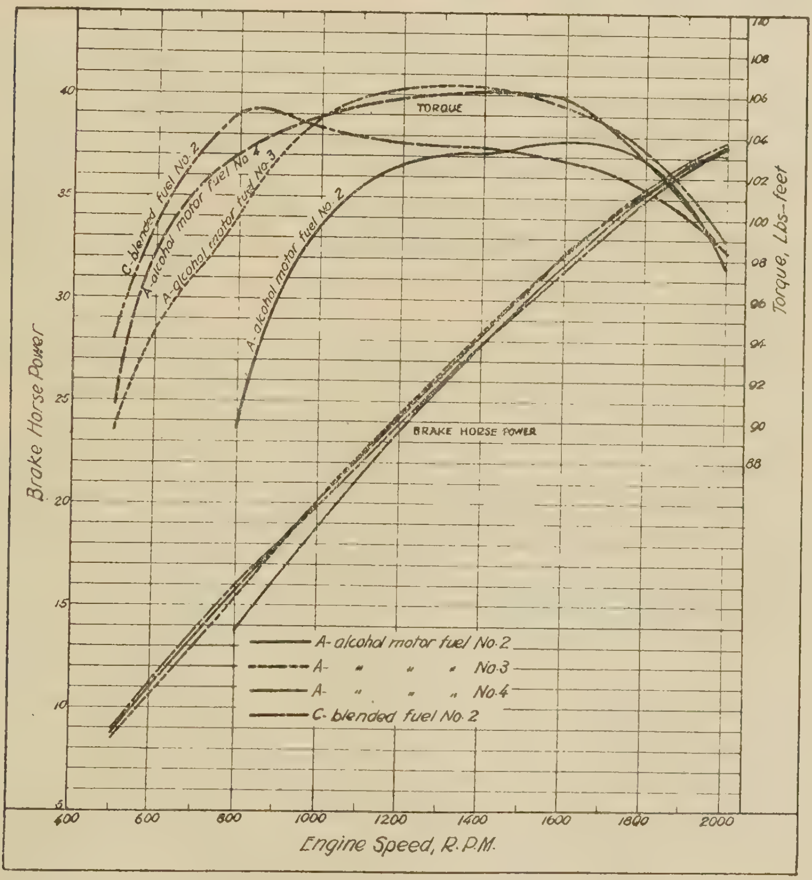

Chart 4.—Performance curves of Chevrolet engine using down-draft carburetor. Full load.

It should be noted that the fuel consumption of gasoline at three-fourths load was about 8 per cent lower than the gasoline consumption at full load. The result with alcohol fuels definitely showed, however, that the lower the load the higher was the fuel consumption per brake horsepower hour.

4. That the engine missed occasionally on all fuels at and below 600 r.p.m.

5. That no difficulty in starting was found with the use of alcohol fuels.

6. That there was evidence of slight detonation when gasoline was used at 2000 r.p.m. on full throttle. This was not observed with the use of alcohol fuels.

7. That the fuel economy using A-alcohol motor fuel No. 1 was reduced about 1.1 per cent when the jet was made just large enough to develop the same power as gasoline. Enlarging the jet, however, caused the engine to increase the power slightly with a correspondingly large increase in fuel consumption.

8. That the engine operation with alcohol fuels was steadier than with gasoline at or near the full capacity. At low speeds and at very light loads, operation with gasoline was a little better than with alcohol fuels.

The results of all the tests using down-draft carburetor are shown in tables 6 to 13 and in charts 4 to 9. The curves shown in charts 4, 5, 6, illustrate the following:

1. That approximately the same maximum power at 2200 r.p.m. was developed when A-alcohol motor fuels Nos. 2, 3, and 4 and C-blended fuel No. 2 were used. The power obtained at low speeds using the A-alcohol fuel No. 2 was a little less than the power developed by the other fuels.

2. That the maximum torque in all fuels appeared at about 1400 r.p.m., except in C-blended fuel No. 2 where the peak was at about 800 r.p.m.

3. That in general, the lower the load the higher the consumption per brake horsepower hour.

4. That the most economical consumption expressed in pounds per brake horsepower hour as derived from the curves was as follows:

FUEL	FULL LOAD	3/4 LOAD	1/2 LOAD	1/4 LOAD
A-alcohol motor fuel No. 2 ..	0.990	1.100	1.320	1.955
A-alcohol motor fuel No. 3 ..	0.985	1.045	1.230	1.828
A-alcohol motor fuel No. 4 ..	0.990	1.061	1.219	1.810
C-blended fuel No. 2	0.776	0.827	0.975	1.310

5. That at or near the highest load for each speed, the fuel economy curves of the A-alcohol motor fuel No. 2 sloped downward more abruptly than the curves of the other fuels.

6. That the larger the amount of gasoline present in the fuel mixture the less the fuel consumption per brake horsepower hour.

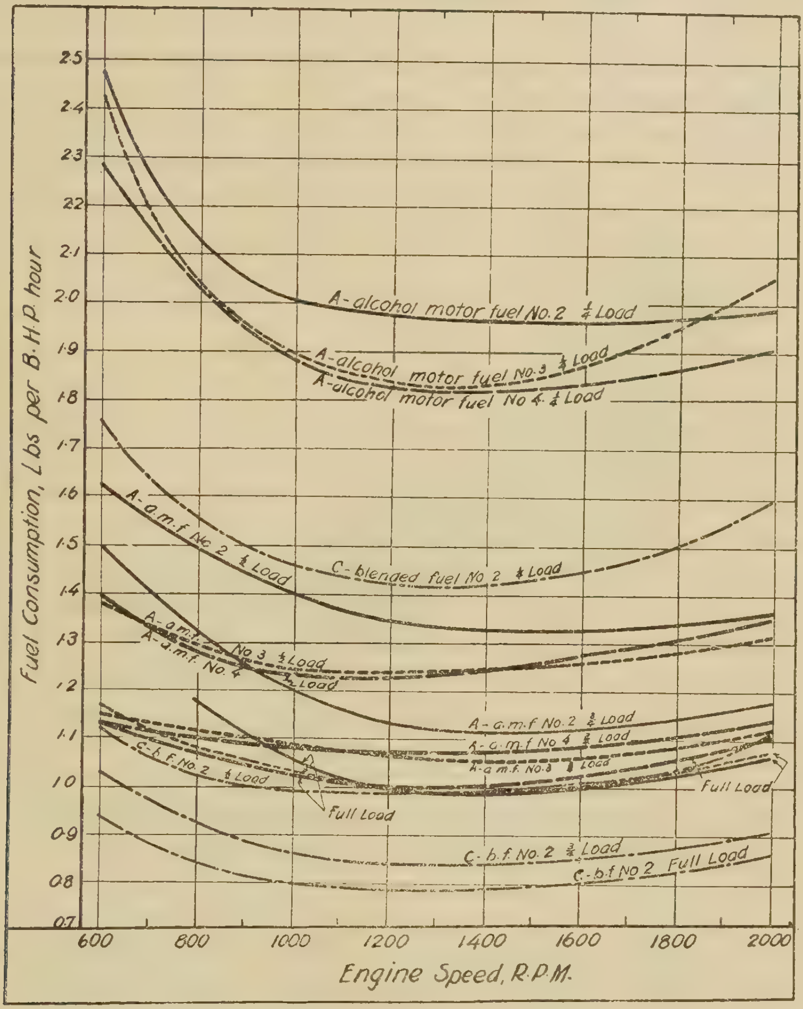

Chart 5.—Fuel economy curves at full, 3/4, 1/2, and 1/4 loads. Chevrolet engine with down-draft carburetor.

The following results are clearly shown in charts 7, 8, 9 and in tables 10, 11, 12, 13.

1. That all the alcohol fuels developed at 2000 r.p.m. about the

same maximum power. The maximum power that could be obtained at that speed using gasoline was about 2 per cent less than the maximum for alcohol fuels. From 1600 r.p.m. and below the A-dehydrated alcohol had less maximum power than gasoline.

2. That the torque curves for A-alcohol motor fuels Nos. 5 and 6 were more uniform than those of gasoline and of A-dehydrated alcohol. The peak for the A-alcohol motor fuel No. 5 and for gasoline was at about 1100 r.p.m. It was located at about 1300 r.p.m. in A-alcohol motor fuel No. 6.

3. That the higher the load the less the fuel consumption per brake horsepower hour. There was, however, a very little difference between the fuel economy of gasoline at full load and at 3/4 load. The most economical consumption expressed in pounds per brake horsepower hour as derived from the curves was as follows:

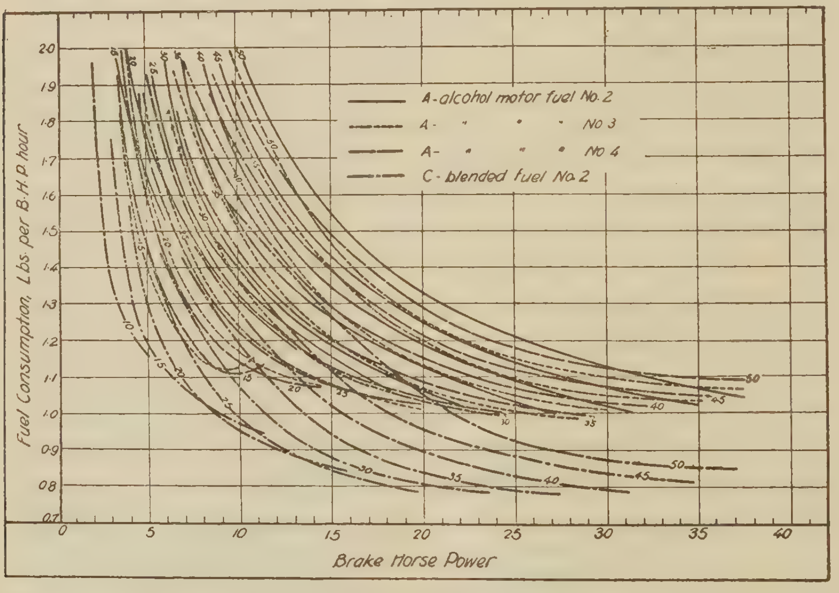

Chart 6.—Relation between fuel consumption and horsepower at different engine speeds. Chevrolet engine with down-draft carburetor. Engine speed expressed in kilometers an hour (speedometer reading).

FUEL	FULL LOAD	3/4 LOAD	1/2 LOAD	1/4 LOAD
A-alcohol motor fuel No. 5 ..	1.040	1.130	1.351	2.000
A-alcohol motor fuel No. 6 ..	0.979	1.055	1.185	1.715
A-dehydrated alcohol	0.901	1.010	1.170	1.700
Gasoline	0.700	0.712	0.829	0.725

4. That it was indicated that the lower the specific gravity of the alcohol fuels, the less was the consumption per brake horsepower hour.

5. That the alcohol fuels had a steadier operation when the mixture used was slightly rich than when lean.

A number of short tests were carried out to determine the effect of pre-heating alcohol fuels when the down-draft carburetor was used. It was definitely shown that full pre-heating shortened the time of warming the engine and decreased the maximum power at higher speeds. The consumption was decreased a little at light loads and at low speeds when the pre-heater was placed at medium position.

The fuel economy at fractional loads at 2000 r.p.m. and at 1400 r.p.m. using different fuels for both up-draft and down-draft carburetors is shown in tables 14 and 15.

The results of tests in series B are given as follows:

A-alcohol motor fuel No. 1

10 hours test

1. *Period of tests*
   a. Warming up = 15 minutes
   b. Load adjustment = 15 minutes
   c. Continuous tests = 600 minutes = 10 hours
   d. Idling after tests = 2 minutes
2. *Load and speed*
   a. Average dynamometer load = 46.4 pounds
   b. Average torque = 101.2 lb.-ft.
   c. Average engine speed = 1,998 r.p.m.
   d. Computed b.h.p. = 38.65
   e. Total b.h.p.-hr. = 386.5
   f. Speedometer distance covered = 537.05 km. = 333.77 miles
   g. Computed rated speed = 53.71 km./hr. = 33.38 miles/hr.
3. *Fuel consumption*
   a. Total amount of fuel consumed = 397.33 lb. = 60.27 gallons = 228.15 liters
   b. Rate
      = 39.73 lb./hr. = 6.027 gallons/hr. = 22.81 liters/hr.
      = 1.026 lb./b.h.p.-hr.
      = 2.35 km./liter
4. *Oil consumption*
   a. Mobiloil A was used
   b. Amount of fresh oil = 5500 cc.
   c. Amount of used oil = 3770 cc.
   d. Difference = 1730 cc.
   e. Dilution after 10 hours = None
   f. Amount of oil consumed = 1730 cc.
   g. Consumption per 100 b.h.p.-hr. = 447.6 cc. = 0.1182 gallon
   h. Temperature of oil = 220°F.
   i. Consumption per 100 km. = 322.16 cc.; per 100 miles = 0.137 gallon

5. *Remarks.* Dynamometer load was only 44.5 pounds in the first 30 minutes. It gradually increased to 46.5 pounds and stayed at this load for over seven hours. Then the load decreased to 46.3 pounds and stayed at this point till the end of the test. The speed remained fairly constant.

6. *a.* Average cooling water temperature = 165°F.
   b. Average room temperature = 91°F.
   c. Average relative humidity = 80%
   d. Down-draft carburetor with No. 42 jet.

6 1/2 hours test

1. *Period of test — 6 1/2 hours*
   a. Warming up = 15 minutes
   b. Load adjustment = 15 minutes
   c. Length of runs.

SPEED	DYNAMOMETER LOAD	TIME
r.p.m.	*lb.*	*min.*
2200	43.2	15
2000	46.5	60
1800	48.3	60
1600	49.6	60
1400	49.5	90
1200	48.5	60
1000	48.2	30

   d. Idling after test = 2 minutes
   e. Total time = 375 minutes

3. *Fuel consumption*

SPEED	POWER	SPEEDOMETER DISTANCE	RATED SPEED	TORQUE
r.p.m.	*b.h.p.*	*km.*	*km./hr.*	*lb.-ft.*
2200	39.60	15.20	60.80	94.4
2000	38.75	54.30	54.30	101.7
1800	36.20	48.80	48.80	105.3
1600	33.10	43.35	43.35	108.5
1400	28.88	56.35	37.56	108.2
1200	24.25	31.20	31.20	106.0
1000	20.08	12.70	25.40	105.3

   a. Total b.h.p.-hr. = 195.56
   b. Total speedometer distance = 261.90 km. = 162.7 miles

3. *Fuel consumption*

SPEED R.P.M.	POUNDS PER B.H.P.-HR.	MILES PER GALLON	KM. PER LITER	POUNDS PER HOUR
2200	1.112	5.64	2.40	44.08
2000	1.068	5.38	2.29	41.34
1800	1.020	5.41	2.32	36.92
1600	0.995	5.38	2.29	32.95
1400	0.981	5.41	2.32	28.35
1200	0.970	5.41	2.32	23.55
1000	1.020	5.07	2.16	20.50

4. *Oil consumption*
   - *a.* Mobiloil A was used
   - *b.* Amount of fresh oil = 5500 cc.
   - *c.* Amount of used oil = 4820 cc.
   - *d.* Difference = 680 cc.
   - *e.* Dilution after 6½ hours = None
   - *f.* Amount of oil consumed = 680 cc. = 0.1796 gallon
   - *g.* Consumption per 100 b.h.p.-hr. = 347.7 cc. = 0.09183 gallon

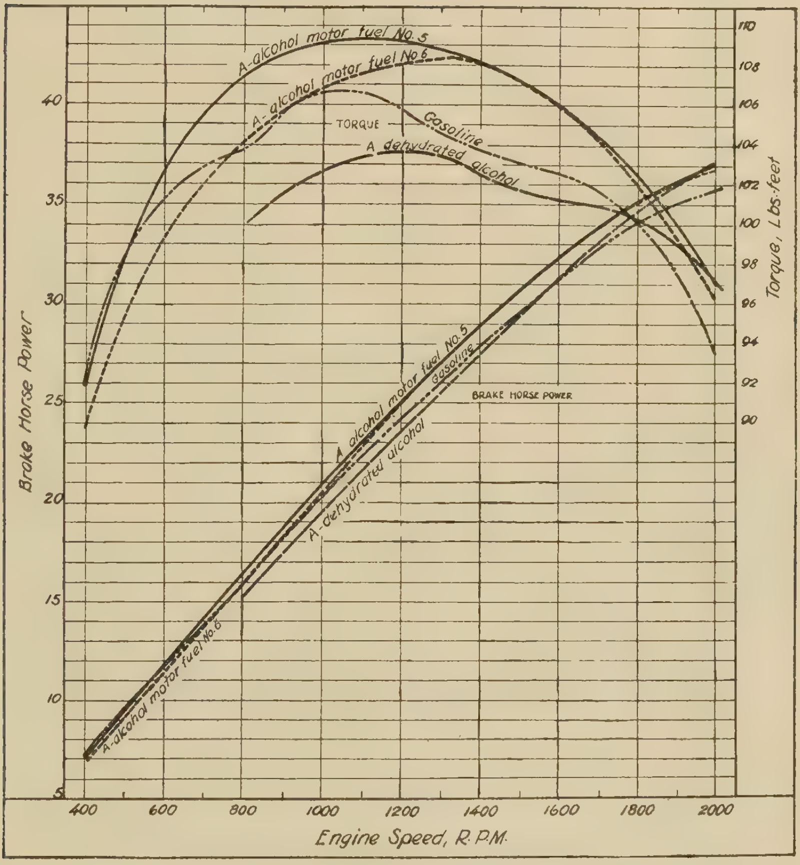

Chart 7.—Performance curves of Chevrolet engine using down-draft carburetor. Full load. Different fuels used.

   - *h.* Consumption per 100 km. = 259.6 cc.
   - *i.* Consumption per 100 miles = 0.110 gallon

5. *a.* Average cooling water temperature = 166°F.
   - *b.* Average room temperature = 92°F.
   - *c.* Average relative humidity = 81 per cent
   - *d.* Down-draft carburetor with No. 42 jet
   - *e.* Total extra kilometers due to changes of loads = 9 km.

B-dehydrated alcohol

10 hours test

1. *Period of tests*
   - *a.* Warming up = 15 minutes
   - *b.* Load adjustment = 15 minutes

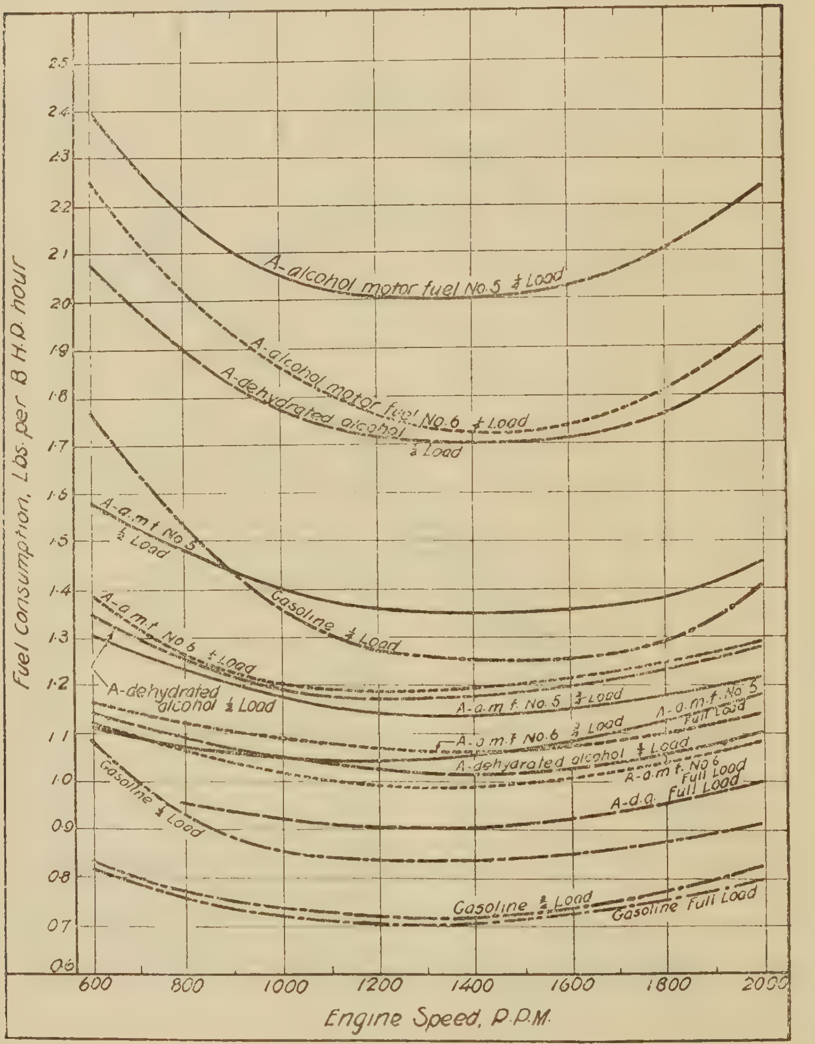

Chart 8.—Fuel economy curves at full, 3/4, 1/2, and 1/4 loads. Chevrolet engine with down-draft carburetor. Different fuels used.

   - *c.* Continuous tests = 600 minutes = 10 hours
   - *d.* Idling after test = 2 minutes

2. *Load and speed*
   a. Average dynamometer load = 46.1 lb.
   b. Average torque = 100.8 lb.-ft.
   c. Average engine speed = 2000 r.p.m.
   d. Computed b.h.p. = 38.40
   e. Total b.h.p.-hr. = 384
   f. Speedometer distance covered = 538 km. = 334.36 miles
   g. Computed rated speed = 53.8 km./hr. = 33.436 miles/hour
3. *Fuel consumption*
   a. Total amount of fuel consumed
      = 370.92 pounds = 57.51 gallons = 217.685 liters
   b. Rate
      = 37.092 pounds/hr. = 5.751 gallons/hr. = 21.77 liters/hr.
      = 0.966 lb./b.h.p.-hr.
      = 5.81 miles/gallon
      = 2.47 km./liter
4. *Oil consumption*
   a. Mobiloil A used
   b. Amount of fresh oil = 5,500 cc.
   c. Amount of used oil = 3,850 cc.
   d. Difference = 1,650 cc.
   e. Dilution after 10 hours = None
   f. Amount of oil consumed = 1,650 cc.
   g. Consumption per 100 b.h.p.-hr. = 429.7 cc. = 0.1135 gallon
   h. Temperature of oil = 218°F.
   i. Consumption per 100 km. = 263.94 cc.; per 100 miles = 0.113 gallon
5. *Remarks.* During the first six hours, dynamometer load and speed were steady at 46.5 pounds and at 1500 r.p.m. The load then decreased by 0.5 pound in the seventh and eighth hours. In the ninth and tenth hours the load was approximately only 45.8 pounds.
6. a. Average cooling water temperature = 166°F.
   b. Average room temperature = 96°F.
   c. Average relative humidity = 77%
   d. Down-draft carburetor with No. 44 jet.

6 1/2 hours test

1. *Period of test — 6 1/2 hours test*
   a. Warming up = 15 minutes
   b. Load adjustment = 15 minutes (Total)
   c. Length of runs

SPEED	DYNAMOMETER LOAD	TIME
r.p.m.	*lb.*	*min.*
2200	44.4	15
2000	47.0	60
1800	48.2	60
1600	49.6	60
1400	49.2	90
1200	48.0	60
1000	47.7	30

   d. Idling after tests = 2 minutes
   e. Total time = 375 minutes

2. *Load and speed*

SPEED	POWER	SPEEDOMETER DISTANCE	RATED SPEED	TORQUE
r.p.m.	*b.h.p.*	*km.*	*km./hr.*	*lb.-ft.*
2200	40.65	14.75	59.00	97.0
2000	39.20	54.30	54.30	102.8
1800	36.10	48.60	48.60	105.2
1600	33.08	43.20	43.20	108.5
1400	28.70	56.68	37.80	107.5
1200	24.00	32.50	32.50	105.0
1000	19.88	13.42	26.85	104.2

a. Total b.h.p.-hr. = 195.53
b. Total speedometer distance = 263.45 km. = 163.73 miles

3. *Fuel consumption*

SPEED R.P.M.	POUNDS PER B.H.P.-HR.	MILES PER GALLON	KM. PER LITER	POUNDS PER HOUR
2200	1.006	5.77	2.46	40.96
2000	1.000	5.54	2.36	39.21
1800	0.959	5.63	2.40	34.64
1600	0.926	5.65	2.41	30.62
1400	0.912	5.79	2.46	26.19
1200	0.928	5.85	2.49	22.26
1000	0.933	5.81	2.47	18.56

4. *Oil consumption*
a. Mobiloil A was used
b. Amount of fresh oil = 5500 cc.
c. Amount of used oil = 4825 cc.
d. Difference = 675 cc.
e. Dilution after 6½ hours = None
f. Amount of oil consumed = 675 cc. = 0.1785 gallon
g. Consumption per 100 b.h.p.-hr. = 345.2 cc. = 0.09129 gallon
h. Consumption per 100 km. = 256.2 cc.
i. Consumption per 100 miles = 0.109 gallon

5. *a.* Average cooling water temperature = 162°F.
b. Average room temperature = 90°F.
c. Average relative humidity = 70%
d. Down-draft carburetor with No. 44 jet
e. Total extra kilometer due to changes of loads = 10 km.

Gasoline

10 hours test

1. *Period of test*
a. Warming up = 15 minutes
b. Load adjustment = 15 minutes
c. Continuous test = 600 minutes
d. Idling after tests = 2 minutes

2. *Load and speed*
a. Average dynamometer load = 46.7 lb.
b. Average torque = 102.2 lb.-ft.

c. Average engine speed = 2000 r.p.m.
d. Computed b.h.p. = 39.95
e. Total b.h.p.-hr. = 399.5
f. Speedometer distance covered = 538 km. = 334.36 miles
g. Computed rated speed = 53.8 km./hr. = 3.436 miles/hr.

3. *Fuel consumption*
a. Total amount of fuel consumed = 315.09 pounds
= 52.44 gallons = 198.62 liters
b. Rate
= 31.51 pounds/hr. = 5.244 gal./hr. = 19.86 liters/hr.
= 0.789 lb./b.h.p.-hr.
= 6.376 miles/gallon
= 2.709 km./liter

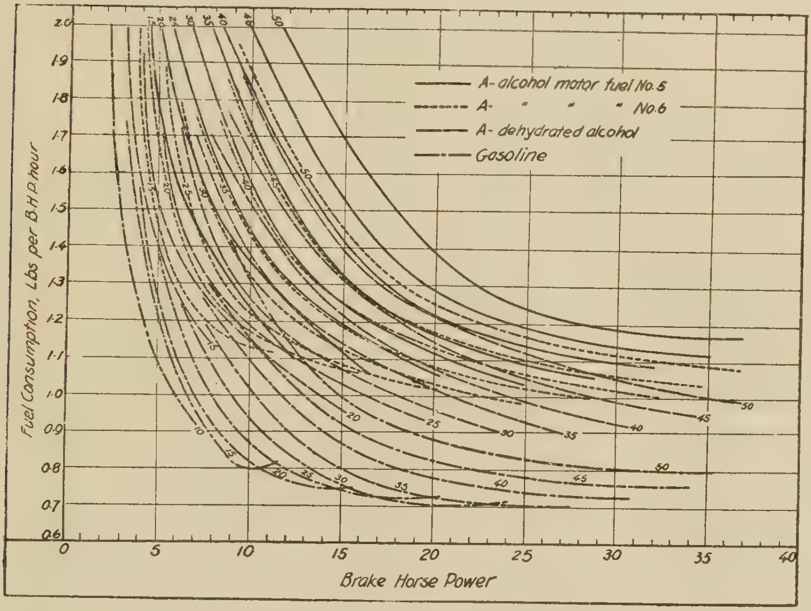

Chart 9.—Relation between fuel consumption and horsepower at different engine speeds. Chevrolet engine with down-draft carburetor. Engine speed expressed in kilometers an hour (speedometer reading). Different fuels used.

4. *Oil consumption*
a. Mobiloil A was used
b. Amount of fresh oil = 5500 cc.
c. Amount of used oil = 4080 cc.
d. Difference = 1420 cc.
e. Dilution after 10 hours = 3.54%
f. Amount of oil consumed = 1564 cc.
g. Consumption per 100 b.h.p.-hr. = 391.4 cc. = 0.1034 gallon
h. Temperature of oil = 210°F.
i. Consumption per 100 km. = 306.69 cc.; per 100 miles = 0.131 gallon

5. *Remarks.* Dynamometer load increased from 46.4 pounds to 46.8 pounds after two hours of operation. The load was maintained at approximately 46.7 pounds for over seven hours. The speed had very insignificant variation.
6. *a.* Average cooling water temperature = 162°F.
   b. Average room temperature = 90°F.
   c. Average relative humidity = 71%
   d. Down-draft carburetor with No. 45 jet

6 1/2 hours test

1. *Period of test* — 6½ hours
   a. Warming up = 15 minutes
   b. Load adjustment = 15 minutes
   c. Length of runs

SPEED	DYNAMOMETER LOAD	TIME
r.p.m.	*lb.*	*min.*
2200	44.0	15
2000	46.7	60
1800	47.0	60
1600	50.0	60
1400	49.4	90
1200	49.3	60
1000	48.4	30

   d. Idling after test = 2 minutes
   e. Total time = 375 minutes

2. *Load and speed*

SPEED	POWER	SPEEDOMETER DISTANCE	RATED SPEED	TORQUE
r.p.m.	*b.h.p.*	*km.*	*km./hr.*	*lb.-ft.*
2200	40.38	15.02	60.08	96.2
2000	39.95	54.25	54.25	102.1
1800	35.25	48.80	48.80	102.8
1600	33.31	43.30	43.30	109.2
1400	28.80	56.18	37.45	108.0
1200	24.65	32.00	32.00	107.8
1000	20.15	13.05	26.10	105.8

   a. Total b.h.p.-hr. = 196.55
   b. Total speedometer distance = 262.60 km. = 163.27 miles

3. *Fuel consumption*

SPEED R.P.M.	POUNDS PER B.H.P.-HR.	MILES PER GALLON	KM. PER LITER	POUNDS PER HOUR
2200	0.838	6.62	2.82	33.80
2000	0.781	6.49	2.76	31.20
1800	0.666	7.75	3.30	23.46
1600	0.624	7.77	3.31	20.76
1400	0.614	7.90	3.36	17.69
1200	0.627	7.73	3.29	15.46
1000	0.639	7.56	3.22	12.86

4. *Oil consumption*
    - *a.* Mobiloil A was used
    - *b.* Amount of fresh oil = 5500 cc.
    - *c.* Amount of used oil = 5070 cc.
    - *d.* Difference = 430 cc.
    - *e.* Dilution after 6½ hours = 3%
    - *f.* Amount of oil consumed = 582 cc. = 0.1538 gallon
    - *g.* Consumption per 100 b.h.p.-hr. = 296.1 cc. = 0.0782 gallon
    - *h.* Consumption per 100 km. = 221.6 cc.
    - *i.* Consumption per 100 miles = 0.094 gallon
5. *a.* Average cooling water temperature = 160°F.
    - *b.* Average room temperature = 86°F.
    - *c.* Average relative humidity = 91%
    - *d.* Down-draft carburetor with No. 45 jet
    - *e.* Total extra kilometers due to changes of loads = 8.5 km.

Summary of 10-hours test

FUEL		A-ALCOHOL MOTOR FUEL NO. 1	B-DEHYDRATED ALCOHOL	GASOLINE
Torque in lb.-ft.		101.2	100.8	102.2
Engine speed in r.p.m.		1998	2000	2000
Power in b.h.p.		38.65	38.40	39.95
Speedometer distance traveled	Km.	537.1	538.0	538.0
	Miles	333.8	334.4	334.4
Speed	Km./hr.	53.71	53.80	53.80
	Miles/hr.	33.38	33.44	33.44
Fuel consumption	Cc./100 b.h.p.-hr	1.026	0.966	0.789
	Gallons/hr.	6.027	5.751	5.244
	Miles/gallon	5.54	5.81	6.37
	Km./liter	2.35	2.47	2.71
	Liters/hr.	22.81	21.77	19.86
Oil consumption	Cc./100 b.h.p.-hr	447.6	429.7	391.4
	Gal./100 b.h.p.-hr.	0.1182	0.1135	0.1034
	Dilution in per cent	None	None	3.54
	Cc./100 km.	322.16	263.94	306.69
	Gallons per 100 miles	0.137	0.113	0.131

- *a.* Warming up =15 minutes
- *b.* Load adjustment = 15 minutes
- *c.* Idling after test = 2 minutes

A study of the amount of carbon deposit as shown in table 16 indicated the following:

1. That the largest amount of carbon deposit was found on the cylinder heads and on piston heads.

2. That the spark plugs had only traces of carbon when alcohol fuels were used.

3. That the tests using alcohol fuels had less carbon than those using gasoline. Considering the carbon deposit obtained in using gasoline as 100 per cent the relative percentage for A-alcohol motor fuel No. 1 was only 64.5 and for the B-dehydrated alcohol, 76.12.

The changes in viscosity of the crank case oil were found as follows: (see table 17.)

1. That after 10 hours of continuous operation of the engine under nearly the same load and running at approximately the same speed the crank case oil became thicker than the original. The degree of thickening was greatest in the test using B-dehydrated alcohol and the least in gasoline. There was oil dilution when gasoline was used. No dilution was found in the tests with alcohol fuels.

2. That the changes in viscosity after only 6½ hours of operation under variable speeds and loads were not as much as those obtained after 10 hours of operation.

When the oil was drained for measurement after each test with alcohol fuels, a small amount of the unburned liquid was found in the sump. It settled at the bottom of the container after allowing the oil to rest.

From the results of ring wear measurement as shown in table 18, the following indications were found:

1. That the average ring wear for all cylinders was largest in the B-dehydrated alcohol and smallest in the A-alcohol motor fuel No. 1.

2. That the largest amount of ring wear was found on the top compression ring in the tests using gasoline and A-alcohol motor fuel No. 1. The scrape ring had the most wear in the B-dehydrated alcohol test.

3. That, considering the total ring wear using gasoline as 100 per cent, the corresponding percentage for A-alcohol motor fuel No. 1 was a little above 80 and for the B-dehydrated alcohol over 300.

TABLE 1

Specifications of engines used

	CHEVROLET	WAUKESHA ENGINE	FORD
Type or series	AE (Independence Model)	XAH	V8—112
Age	20 months	New	New
Cylinders	6	4	8
Bore	3–5/16″	3–5/8″	3–1/16″
Stroke	3–3/4″	4–1/2″	3–3/4″
Displacement (cu.in.)	194	186	221
N.A.C.C. h.p.	26.3	21.0	30.0 (S.A.E.)
Rating (actual h.p. is higher)	(Max. b.h.p. at 2600 r.p.m. = 50)	(Max. b.h.p. from curve at 2500 r.p.m. = 38)	(Max. b.h.p. at 3400 r.p.m. = 75)
Materials (piston)	Cast iron (light weight)	Cast iron	Special heat treated aluminum alloy
(head)	Cast iron	Cast iron	Aluminum alloy
Compression ratio	5.00 to 1	Low compression approx. 4.56 to 1 High compression approx. 6.67 to 1	6.33 to 1
Carburetor make	Up-draft—Carter Down-draft—Carter	Zenith (New 90 series)	Special Ford-Detroit Lubricator. Down-draft

TABLE 2

Results of tests on variable speeds and loads using gasoline
(1 gallon = 6.1542 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
Full load						
41.3	2000	34.40	27.00	0.785	7.09	Cooling water temp. — 159°F.
43.0	1800	32.25	24.80	0.769	6.94	
44.1	1600	29.40	22.20	0.755	6.90	Barometer reading — 29.94 in. Hg.
45.3	1400	26.40	19.80	0.750	6.76	Rel. humidity — 74%
45.6	1200	22.80	17.40	0.763	6.60	Carburetor jet No. 57
45.8	1000	19.10	15.20	0.796	6.29	Room temp. — 85°F.
45.5	800	15.17	12.50	0.825	6.12	
43.8	600	10.95	9.50	0.867	6.04	
40.0	400	6.67	6.00	0.900	6.38	
Three-fourths load						
30.9	2000	25.80	18.80	0.728	10.18	Cooling water temp. — 160°F.
32.3	1800	24.22	17.20	0.710	10.01	
33.1	1600	22.08	15.20	0.689	10.08	Barometer reading — 29.93 in. Hg.
33.9	1400	19.75	13.80	0.698	9.72	Rel. humidity 75%
34.2	1200	17.10	12.00	0.701	9.56	Room temp. — 86°F.
34.4	1000	14.33	10.20	0.711	9.38	
34.2	800	11.40	8.20	0.719	9.34	
32.8	600	8.20	6.00	0.732	9.56	
30.0	400	5.00	3.80	0.760	10.08	
One-half load						
20.6	2000	17.17	15.00	0.874	12.78	Cooling water temp. — 163°F.
21.5	1800	16.15	13.80	0.855	12.48	
22.1	1600	14.72	12.40	0.841	12.35	Barometer reading — 29.95 in. Hg.
22.6	1400	13.18	11.00	0.835	12.20	Rel. humidity — 71%
22.8	1200	11.40	9.40	0.824	12.22	Room temp. — 89°F.
22.9	1000	9.54	8.00	0.838	11.96	
22.8	800	7.60	6.40	0.842	11.98	
21.9	600 [b]	5.47	4.70	0.859	12.22	
20.0	400	3.33	3.30	1.051	11.61	
One-fourth load						
10.3	2000	8.57	12.40	1.446	15.45	Cooling water temp. — 157°F.
10.7	1800	8.02	10.80	1.345	15.92	
11.0	1600	7.34	9.20	1.254	16.65	Barometer reading — 29.94 in. Hg.
11.3	1400	6.60	8.00	1.212	16.75	Rel. humidity — 58%
11.4	1200	5.72	7.00	1.228	16.42	Room temp. — 92°F.
11.4	1000	4.75	5.90	1.242	16.23	
11.4	800	3.80	4.90	1.300	15.63	
10.9	600	2.72	3.80	1.395	15.12	
10.0	400	1.67	2.60	1.557	14.72	

[a] Speedometer miles per gallon.
[b] Operation not steady.

TABLE 3

Results of tests on variable speeds and loads using A-special motor fuel (1 gallon = 6.6565 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
			Full load			
42.6	2000	35.59	36.80	1.034	5.63	Cooling water temp. = 162°F.
44.3	1800	33.20	33.50	1.009	5.56	
45.5	1600	30.30	30.10	0.993	5.50	Barometer reading = 29.90 in. Hg
45.8	1400	26.72	26.50	0.991	5.46	Rel. humidity = 45%
46.0	1200	23.00	22.60	0.981	5.49	Carburetor jet No. 55
46.0	1000	19.45	19.20	0.982	5.39	Room temp. = 98°F.
46.6	800	15.53	15.70	1.010	5.28	
45.0	600	11.25	11.80	1.048	5.26	
42.8	400	7.13	7.80	1.093	5.31	
			Three-fourths load			
32.0	2000	26.69	28.90	1.082	7.16	Cooling water temp. = 158°F.
33.3	1800	24.98	26.50	1.061	7.03	
34.1	1600	22.71	23.90	1.050	6.93	Barometer reading = 29.90 in. Hg.
34.4	1400	20.08	20.80	1.035	6.97	Rel. humidity = 50%
34.5	1200	17.25	17.80	1.032	6.98	Room temp. = 99°F.
34.5	1000	14.37	15.00	1.042	6.90	
34.9	800	11.63	12.40	1.067	6.68	
33.7	600	8.42	9.40	1.117	6.60	
32.1	400	5.35	6.60	1.234	6.27	
			One-half load			
21.3	2000	17.75	23.00	1.293	9.00	Cooling water temp. = 159°F.
22.2	1800	16.65	20.60	1.238	9.03	
22.8	1600	15.21	18.40	1.209	9.00	Barometer reading = 29.87 in. Hg.
22.9	1400	13.36	16.20	1.212	8.94	Rel. humidity = 44%
23.0	1200	11.50	14.00	1.216	8.86	Room temp. = 96°F.
23.0	1000	9.58	11.80	1.232	8.76	
23.3	800	7.77	9.90	1.272	8.36	
22.5	600	5.62	7.60	1.352	8.16	
21.6	400	3.60	5.40	1.500	7.66	
			One-fourth load			
10.7	2000	8.91	17.20	1.930	12.02	Cooling water temp. = 160°F.
11.1	1800	8.30	15.30	1.825	12.18	
11.4	1600	7.59	13.80	1.795	12.00	Barometer reading = 29.89 in. Hg.
11.4	1400	6.65	12.00	1.802	12.05	Rel. humidity = 44%
11.5	1200	5.75	10.40	1.809	11.93	Room temp. = 97°F.
11.5	1000	4.79	8.80	1.837	11.78	
11.6	800	3.87	7.30	1.885	11.36	
11.2	600	2.80	5.60	2.000	11.09	
11.0	400	1.83	4.00	2.185	10.34	

[a] Speedometer miles per gallon.

TABLE 4

Results of tests on variable speeds and loads using A-dehydrated alcohol (1 gallon = 6.5515 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
			Full load			
42.5	2000	35.41	36.20	1.022	5.63	Cooling water temp. = 163° F.
44.2	1800	33.15	33.00	0.994	5.55	
45.5	1600	30.30	29.40	0.971	5.54	Barometer reading = 29.91 in. Hg.
46.0	1400	26.81	26.80	0.961	5.32	Rel. humidity = 70%
46.1	1200	23.05	22.10	0.960	5.53	Carburetor jet No. 55
46.6	1000	19.45	18.90	0.972	5.38	Room temp. = 88° F.
47.0	800	15.67	15.40	0.983	5.29	
46.0	600	11.50	11.80	1.026	5.17	
42.7	400	7.11	7.60	1.069	5.36	
			Three-fourths load			
31.8	2000	26.50	28.20	1.064	7.22	Cooling water temp. = 158° F.
33.2	1800	24.90	25.40	1.020	7.22	
34.1	1600	22.72	23.00	1.012	7.08	Barometer reading = 29.94 in. Hg.
34.5	1400	20.10	20.20	1.003	7.06	Rel. humidity = 67%
34.6	1200	17.30	17.40	1.005	7.02	Room temp. = 90° F.
35.0	1000	14.58	14.80	1.015	6.88	
35.2	800	11.73	12.20	1.040	6.67	
34.5	600	8.62	9.30	1.079	6.56	
32.0	400	5.37	6.30	1.172	6.46	
			One-half load			
21.2	2000	17.65	22.20	1.257	9.17	Cooling water temp. = 155° F.
22.1	1800	16.58	20.20	1.218	9.07	
22.8	1600	15.20	18.20	1.198	8.96	Barometer reading = 29.92 in. Hg.
23.0	1400	13.41	15.80	1.178	9.03	Rel. humidity = 67%
23.0	1200	11.50	13.60	1.182	8.98	Room temp. = 91° F.
23.3	1000	9.70	11.60	1.198	8.78	
23.5	800	7.83	9.60	1.226	8.48	
23.0	600[b]	5.75	7.20	1.252	8.46	
21.3	400	3.55	5.00	1.408	8.15	
			One-fourth load			
10.7	2000	8.93	16.80	1.880	12.11	Cooling water temp. = 153° F.
11.0	1800	8.25	14.60	1.770	12.55	
11.3	1600	7.52	13.10	1.741	12.41	Barometer reading = 29.95 in. Hg.
11.5	1400	6.70	11.60	1.731	12.29	Rel. humidity = 58%
11.5	1200	5.75	9.90	1.722	12.33	Room temp. = 95° F.
11.6	1000	4.83	8.40	1.740	12.12	
11.7	800	3.90	7.00	1.792	11.62	
11.5	600	2.87	5.60	1.950	10.91	
10.7	400	1.78	4.00	2.248	10.18	

[a] Speedometer miles per gallon.

[b] Operation not steady.

TABLE 5

Results of tests on variable speeds and loads using A-alcohol motor fuel No. 1 (1 gallon = 6.7373 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
			Full load			
44.4	2000	37.00	42.60	1.151	4.91	Cooling water temp. = 157°F.
46.4	1800	34.80	38.80	1.115	4.86	
47.8	1600	31.85	34.60	1.087	4.84	Barometer reading = 30.00 in. Hg.
48.5	1400	28.27	30.20	1.068	4.86	Rel. humidity = 77%
48.8	1200	24.40	26.00	1.066	4.84	Carburetor jet No. 54
49.0	1000	20.41	21.60	1.058	4.85	Room temp. = 86°F.
49.1	800	16.36	17.60	1.076	4.76	
47.9	600	11.97	13.40	1.120	4.69	
43.6	400	7.28	8.60	1.181	4.87	
			Three-fourths load			
33.3	2000	27.72	31.40	1.132	6.66	Cooling water temp. = 158°F.
34.8	1800	26.10	29.20	1.120	6.67	
35.8	1600	23.86	26.50	1.109	6.32	Barometer reading = 30.02 in. Hg.
36.4	1400	21.21	23.40	1.102	6.26	Rel. humidity = 71%
36.6	1200	18.30	20.20	1.103	6.22	Room temp. = 90°F.
36.7	1000	15.28	17.20	1.126	6.08	
36.8	800	12.27	14.40	1.172	5.82	
35.9	600	8.975	11.20	1.248	5.61	
32.7	400	5.45	7.20	1.327	5.82	
			One-half load			
22.4	2000	18.68	24.80	1.329	8.43	Cooling water temp. = 156°F.
23.2	1800	17.40	23.00	1.322	8.18	
23.9	1600	15.95	21.00	1.318	7.97	Barometer reading = 30.03 in. Hg.
24.3	1400	14.16	18.80	1.328	7.79	Rel. humidity = 72%
24.4	1200	12.20	16.50	1.351	7.56	Room temp. = 95°F.
24.5	1000	10.21	14.20	1.389	7.37	
24.5	800	8.17	11.70	1.432	7.16	
24.0	600	6.00	9.20	1.534	6.82	
21.9	400	3.65	6.20	1.700	6.75	
			One-fourth load			
11.1	2000	9.26	19.60	2.118	10.66	Cooling water temp. = 156°F.
11.6	1800	8.69	17.60	2.028	10.69	
11.9	1600	7.94	15.60	1.965	10.71	Barometer reading = 30.01 in. Hg.
12.1	1400	7.04	13.60	1.933	10.78	Rel. humidity = 64%
12.2	1200	6.10	11.80	1.933	10.62	Room temp. = 95°F.
12.2	1000	5.09	9.80	1.925	10.67	
12.3	800	4.10	8.20	2.000	10.19	
11.9	600	2.98	6.40	2.145	9.81	
10.7	400	1.78	5.20	2.360	8.02	

[a] Speedometer miles per gallon.

TABLE 6

Results of tests on variable speeds and loads using A-alcohol motor fuel No. 2 (1 gallon = 6.6832 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSE-POWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
				Full load		
44.6	2030	37.70	39.47	1.047	5.37	Cooling water temp. = 152° F.
47.0	1800	35.21	36.12	1.025	5.18	
47.5	1600	31.62	31.64	1.002	5.26	Barometer reading = 29.85 in. Hg.
47.2	1400	27.50	27.40	0.995	5.32	Rel. humidity = 74%
47.0	1200	23.50	23.52	1.000	5.31	Carburator jet No. 42
45.5	1000	18.95	19.80	1.044	5.26	Room temp. = 96° F.
41.0	800	13.64	15.90	1.165	5.24	
—	600	Engine not operating uniformly				
				Three-fourths load		
32.5	2010	27.20	31.80	1.168	6.55	Cooling water temp. = 150° F.
34.1	1800	26.20	29.60	1.130	6.32	
36.7	1600	24.42	27.20	1.111	6.13	Barometer reading = 29.96 in. Hg.
36.7	1400	21.40	23.60	1.102	6.18	Rel. humidity = 80%
36.2	1200	18.10	20.10	1.110	6.22	Room temp. = 88° F.
33.4	1000	13.90	16.70	1.200	6.24	
30.5	800	10.17	13.32	1.310	6.25	
24.0	600	6.00	9.18	1.530	6.82	
—	500	Engine not operating uniformly				
				One-half load		
23.5	2020	19.75	26.60	1.347	7.83	Cooling water temp. = 148° F.
23.2	1800	17.40	23.30	1.338	8.06	
23.2	1600	15.47	20.60	1.332	8.10	Barometer reading = 30.00 in. Hg.
23.0	1400	13.41	17.80	1.325	8.20	Rel. humidity = 71%
22.8	1200	11.40	15.20	1.332	8.22	Room temp. = 91° F.
22.0	1000	9.16	13.00	1.418	8.01	
22.0	800	7.33	11.00	1.500	7.57	
21.0	600	5.25	8.67	1.650	7.20	
—	500	Operation not steady				
				One-fourth load		
12.2	2025	10.30	20.40	1.980	10.22	Cooling water temp. = 146° F.
12.0	1800	9.00	17.60	1.957	10.66	
12.3	1600	8.19	16.00	1.951	10.41	Barometer reading = 29.86 in. Hg.
12.0	1400	7.00	13.70	1.957	10.62	Rel. humidity = 58%
12.1	1200	6.05	11.93	1.975	10.47	Room temp. = 92° F.
12.0	1000	5.00	9.97	1.995	10.45	
11.7	800	3.90	8.27	2.121	10.08	
10.8	600	2.70	6.69	2.480	9.34	
—	500	Operation not steady				

[a] Speedometer miles per gallon.

TABLE 7

Results of tests on variable speeds and loads using A-alcohol motor fuel No. 3 (1 gallon = 6.6448 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
			Full load			
45.2	2000	37.70	40.00	1.060	5.16	Cooling water temp. = 160°F.
47.3	1800	35.50	36.50	1.028	5.23	
48.3	1600	32.20	32.50	1.008	5.08	Barometer reading = 30.00 in. Hg.
48.7	1400	28.40	28.20	0.982	5.13	Rel. humidity = 70%
48.7	1200	24.30	24.30	1.000	5.10	Carburetor jet No. 42
48.0	1000	20.00	20.20	1.010	5.12	Room temp. = 86°F.
45.7	800	15.20	16.40	1.078	5.03	
43.2	600	10.80	12.50	1.157	4.96	
41.0	500	8.54	10.60	1.242	4.87	
			Three-fourths load			
34.8	2000	29.00	32.00	1.103	6.45	Cooling water temp. = 158°F.
35.4	1800	26.55	28.60	1.077	6.49	
36.2	1600	24.12	25.50	1.055	6.48	Barometer reading = 30.02 in. Hg.
36.5	1400	21.30	22.40	1.051	6.45	Rel. humidity = 71%
36.5	1200	18.25	19.30	1.057	6.42	Room temp. = 92°F.
36.0	1000	15.00	16.20	1.080	6.37	
34.2	800	11.40	12.80	1.121	6.45	
32.4	600	8.10	9.20	1.135	6.73	
30.6	500	6.37	7.60	1.194	6.79	
32.5	400	Good operation. Constant load and r.p.m.				
			One-half load			
22.5	2000	18.75	24.30	1.295	8.49	Cooling water temp. = 159°F.
23.5	1800	17.62	22.30	1.270	8.25	
24.2	1600	16.15	20.20	1.250	8.17	Barometer reading = 30.02 in. Hg.
24.2	1400	14.11	17.50	1.240	8.26	Rel. humidity = 75%
24.2	1200	12.10	14.90	1.232	8.31	Room temp. = 94°F.
24.0	1000	10.00	12.40	1.240	8.32	
22.8	800	7.60	9.90	1.300	8.33	
21.6	600	5.40	7.40	1.370	8.37	
—	500	Operation not very smoothly				
			One-fourth load			
11.3	2000	9.40	18.60	2.045	11.10	Cooling water temp. = 154°F.
11.6	1800	8.69	16.70	1.930	11.10	
12.0	1600	8.00	14.90	1.861	11.08	Barometer reading = 30.00 in. Hg.
12.4	1400	7.22	13.20	1.830	10.93	Rel. humidity = 71%
12.3	1200	6.15	11.30	1.835	10.93	Room temp. = 90°F.
12.0	1000	5.00	9.45	1.890	10.92	
11.0	800	3.67	7.40	2.016	11.16	
11.2	600	2.80	6.81	2.430	9.09	
—	500	Operation shaky				

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[a] Speedometer miles per gallon.

TABLE 8

Results of tests on variable speeds and loads using A-alcohol motor fuel No. 4 (1 gallon = 6.5882 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
Full load						
45.00	2000	37.50	41.04	1.093	4.98	Cooling water temp. = 152°F.
47.00	1800	35.22	36.96	1.048	4.98	
48.50	1600	32.30	32.76	1.013	5.01	Barometer reading = 30.00 in. Hg.
48.60	1400	28.30	28.20	0.995	5.08	Rel. humidity = 52%
48.50	1200	24.24	24.12	0.994	5.09	Carburetor jet No. 42
48.00	1000	20.00	20.52	1.026	4.99	Room temp. = 94.5°F.
47.20	800	15.71	16.80	1.068	4.88	
45.00	600	11.23	12.72	1.132	4.83	
41.50	500	8.64	10.44	1.208	4.90	
Three-fourths load						
35.00	2000	29.18	32.76	1.122	6.24	Cooling water temp. = 160°F.
35.60	1800	26.70	29.28	1.098	6.29	
36.40	1600	24.30	26.12	1.075	6.27	Barometer reading = 29.93 in. Hg.
36.40	1400	21.21	22.56	1.067	6.36	Rel. humidity = 45%
36.00	1200	18.00	19.20	1.068	6.40	Room temp. = 96°F.
36.00	1000	15.00	16.08	1.072	6.37	
35.00	800	11.67	12.72	1.090	6.43	
34.60	600	8.54	9.60	1.125	6.42	
30.40	500	6.33	7.44	1.175	6.88	
29.00	400	4.83	6.12	1.268	6.70	
One-half load						
22.40	2000	18.68	24.84	1.332	8.24	Cooling water temp. = 162°F.
23.40	1800	17.55	22.70	1.292	8.10	
23.80	1600	15.85	20.04	1.262	8.19	Barometer reading = 29.92 in. Hg.
24.00	1400	14.00	17.30	1.235	8.27	Rel. humidity = 52%
24.00	1200	12.00	14.63	1.220	8.38	Room temp. = 95°F.
24.00	1000	10.00	12.32	1.232	8.30	
23.00	800	7.66	9.72	1.269	8.43	
21.70	600	5.42	7.56	1.395	8.13	
20.70	530	4.57	7.06	1.547	7.52	
16.50	400	2.75	5.40	1.964	7.59	
One-fourth load						
12.00	2000	10.00	18.96	1.896	10.80	Cooling water temp. = 158°F.
11.60	1800	8.69	16.12	1.855	11.42	
11.70	1600	7.80	14.20	1.820	11.55	Barometer reading = 29.93 in. Hg.
11.50	1400	6.70	12.20	1.820	11.75	Rel. humidity = 64%
11.30	1200	5.65	10.30	1.825	11.91	Room temp. = 91°F.
11.50	1000	4.79	9.00	1.880	11.38	
11.20	800	3.73	7.60	2.035	10.78	
10.60	600	2.60	6.00	2.300	10.23	
10.50	500	2.18	5.40	2.480	9.48	

[a] Speedometer miles per gallon.

TABLE 9

Results of tests on variable speeds and loads using C-blended fuel No. 2 (60% alcohol, 35% gasoline, 5% benzol) (1 gallon = 6.5149 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
			Full load			
45.00	2000	37.50	31.80	0.847	6.36	Cooling water temp. = 160°F.
46.50	1800	34.83	28.20	0.809	6.45	
47.00	1600	31.30	24.40	0.780	6.64	Barometer reading = 30.04 in. Hg.
47.50	1400	27.70	21.60	0.780	6.25	Rel. humidity = 65%
47.50	1200	23.75	18.60	0.782	6.53	Carburetor jet No. 45
47.80	1000	19.92	15.60	0.783	6.49	Room temp. = 96°F.
48.10	800	16.03	13.50	0.840	6.00	
45.50	600	11.38	9.80	0.948	6.26	
43.00	500	8.95	9.00	1.005	5.62	
			Three-fourths load			
33.70	2000	28.10	25.00	0.889	8.08	Cooling water temp. = 154°F.
35.10	1800	26.30	22.80	0.867	8.09	
35.20	1600	23.47	19.80	0.842	8.17	Barometer reading = 29.96 in. Hg.
35.70	1400	20.82	17.30	0.830	8.18	Rel. humidity = 66%
35.70	1200	17.85	14.80	0.828	8.20	Room temp. = 96°F.
35.80	1000	14.91	12.60	0.845	8.02	
36.00	800	12.00	10.00	0.916	8.10	
33.00	600	8.25	8.40	1.018	7.23	
30.00	400	5.00	5.80	1.160	6.97	
			One-half load			
22.50	2000	18.75	20.80	1.109	9.72	Cooling water temp. = 155°F.
23.10	1800	17.31	17.80	1.028	10.22	
23.50	1600	15.60	15.70	1.005	10.29	Barometer reading = 29.94 in. Hg.
23.70	1400	13.81	13.60	0.983	10.40	Rel. humidity = 65%
23.70	1200	11.85	11.60	0.979	11.62	Room temp. = 96°F.
23.90	1000	9.95	9.80	0.985	10.32	
24.00	800	8.00	8.10	1.012	10.00	
22.80	600	5.70	6.40	1.122	9.49	
20.00	400	3.33	4.20	1.261	9.64	
			One-fourth load			
11.25	2000	9.36	14.80	1.580	13.68	Cooling water temp. = 152°F.
11.50	1800	8.62	12.80	1.495	14.20	
11.70	1600	7.80	11.20	1.438	14.40	Barometer reading = 29.94 in. Hg.
11.90	1400	6.94	9.80	1.412	14.45	Rel. humidity = 65%
11.90	1200	5.95	8.40	1.412	14.45	Room temp. = 97°F.
11.90	1000	4.96	7.20	1.452	14.05	
12.00	800	4.00	6.20	1.550	13.05	
11.40	600	2.85	5.00	1.756	12.12	
11.00	400	1.83	3.60	1.965	11.23	

[a] Speedometer miles per gallon.

TABLE 10

Results of tests on variable speeds and loads using A-alcohol motor fuel No. 5 (1 gallon = 6.6757 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
			Full load			
44.30	2000	36.90	43.30	1.172	4.80	Cooling water temp. = 160°F.
47.00	1800	35.22	39.40	1.117	4.75	
48.40	1600	32.22	35.00	1.085	4.76	Barometer reading = 29.94 in. Hg.
49.50	1400	28.88	30.30	1.050	4.80	Rel. humidity = 59%
50.00	1200	25.00	25.90	1.035	4.82	Carburetor jet No. 42
50.00	1000	20.42	21.50	1.050	4.84	Room temp. = 96°F.
49.30	800	16.43	17.50	1.063	4.76	
47.10	600	11.78	13.20	1.121	4.73	
42.00	400	7.00	9.00	1.285	4.63	
			Three-fourths load			
33.30	2000	27.50	33.20	1.207	6.26	Cooling water temp. = 164°F.
35.30	1800	26.50	31.00	1.170	6.04	
36.30	1600	24.18	27.80	1.150	5.98	Barometer reading = 29.94 in. Hg.
37.10	1400	21.63	24.60	1.133	5.92	Rel. humidity = 60%
37.50	1200	18.75	21.40	1.141	5.83	Room temp. = 96°F.
37.40	1000	15.58	18.30	1.173	5.68	
36.80	800	12.27	15.10	1.232	5.51	
35.50	600	8.87	11.50	1.298	5.42	
30.60	400	5.10	8.40	1.648	4.95	
			One-half load			
22.20	2000	18.50	27.00	1.460	7.70	Cooling water temp. = 166°F.
23.50	1800	17.63	24.20	1.371	7.72	
24.20	1600	16.13	22.00	1.362	7.56	Barometer reading = 29.94 in. Hg.
24.70	1400	14.40	19.60	1.360	7.42	Rel. humidity = 65%
25.00	1200	12.50	17.00	1.360	7.34	Room temp. = 93°F.
25.00	1000	10.41	14.60	1.401	7.12	
24.50	800	8.17	12.20	1.492	6.81	
23.50	600	5.87	9.20	1.567	6.78	
20.80	400	3.47	7.20	2.053	5.77	
			One-fourth load			
11.10	2000	9.25	20.60	2.227	10.08	Cooling water temp. = 162°F.
11.50	1800	8.62	18.00	2.088	10.38	
12.30	1600	8.19	16.60	2.027	10.00	Barometer reading = 29.94 in. Hg.
12.50	1400	7.30	14.70	2.010	9.88	Rel. humidity = 65%
12.70	1200	6.35	12.80	2.016	9.74	Room temp. = 93°F.
12.80	1000	5.33	10.80	2.028	9.62	
12.30	800	4.10	9.00	2.192	9.26	
12.00	600	3.00	7.20	2.400	8.55	
10.80	400	1.80	5.00	2.780	8.31	

[a] Speedometer miles per gallon.

TABLE 11

Results of tests on variable speeds and loads using A-alcohol motor fuel No. 6 (1 gallon = 6.5882 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal* [a]	
				Full load		
44.0	2000	37.00	40.00	1.081	5.12	Cooling water temp. = 160°F.
46.7	1800	35.00	36.00	1.030	5.12	
48.5	1600	32.30	32.40	1.003	5.06	Barometer reading = 29.94 in. Hg.
49.5	1400	28.85	28.60	0.992	5.02	Rel. humidity = 72%
49.5	1200	24.75	24.40	0.988	5.04	Carburetor jet No. 43
49.0	1000	20.41	20.70	1.015	4.94	Room temp. = 96°F.
47.5	800	15.83	16.80	1.061	4.88	
45.5	600	11.38	12.80	1.125	4.80	
41.0	400	6.83	8.00	1.171	5.12	
				Three-fourths load		
33.6	2000	28.00	31.80	1.136	6.44	Cooling water temp. = 161°F.
35.2	1800	26.40	28.80	1.091	6.40	
36.4	1600	24.26	26.00	1.070	6.31	Barometer reading = 29.94 in. Hg.
37.1	1400	21.65	23.00	1.061	6.23	Rel. humidity = 73%
37.2	1200	18.60	19.80	1.066	6.21	Room temp. = 95°F.
36.8	1000	15.33	16.70	1.088	6.14	
35.4	800	11.80	13.20	1.120	6.21	
34.0	600	8.50	9.80	1.152	6.27	
30.0	400	5.00	6.00	1.200	6.82	
				One-half load		
22.2	2000	18.50	23.80	1.287	8.60	Cooling water temp. = 162°F.
23.4	1800	17.53	21.70	1.238	8.50	
24.3	1600	16.20	19.70	1.217	8.32	Barometer reading = 29.94 in. Hg.
24.6	1400	14.35	17.20	1.198	8.34	Rel. humidity = 72%
24.8	1200	12.40	14.80	1.192	8.30	Room temp. = 93°F.
24.6	1000	10.25	12.20	1.190	8.33	
23.7	800	7.90	9.90	1.252	8.27	
21.9	600	5.48	7.56	1.381	8.13	
				One-fourth load		
11.2	2000	9.33	18.00	1.930	11.38	Cooling water temp. = 163°F.
11.6	1800	8.70	15.80	1.817	11.66	
12.2	1600	8.14	14.10	1.733	11.62	Barometer reading = 29.95 in. Hg.
12.6	1400	7.35	12.60	1.713	11.37	Rel. humidity = 72%
12.4	1200	6.20	10.90	1.760	11.28	Room temp. = 96°F.
12.4	1000	5.17	9.50	1.840	10.78	
11.6	800	3.83	7.80	2.019	10.50	
11.4	600	2.85	6.40	2.245	9.58	

[a] Speedometer miles per gallon.

TABLE 12

Results of tests on variable speeds and loads using A-dehydrated alcohol (1 gallon = 6.5515 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
			Full load			
44.4	2000	36.99	36.60	0.990	5.66	Cooling water temp. = 161°F.
45.9	1800	34.42	33.00	0.958	5.55	
46.3	1600	30.85	28.60	0.926	5.69	Barometer reading = 30.06 in. Hg.
46.9	1400	27.40	24.60	0.898	5.79	Rel. humidity = 77%
47.5	1200	23.75	21.40	0.901	5.71	Carburetor jet No. 43
47.0	1000	19.58	18.20	0.929	5.60	Room temp. = 91°F.
45.7	800	15.23	14.40	0.945	5.66	
—	600	Missing slightly				
			Three-fourths load			
33.3	2000	27.79	30.40	1.094	6.82	Cooling water temp. = 159°F.
34.4	1800	25.80	27.00	1.048	6.91	
34.7	1600	23.12	23.60	1.020	7.03	Barometer reading = 30.05 in. Hg.
35.2	1400	20.52	20.80	1.012	6.97	Rel. humidity = 71%
35.5	1200	17.75	18.10	1.020	6.87	Room temp. = 92°F.
35.3	1000	14.70	15.40	1.048	6.73	
34.3	800	11.43	12.40	1.083	6.69	
31.2	600	7.80	8.90	1.140	6.98	
28.5	400	4.75	6.60	1.389	6.28	
			One-half load			
22.2	2000	18.50	23.50	1.270	8.65	Cooling water temp. = 154°F.
23.0	1800	17.25	21.20	1.229	8.80	
23.3	1600	15.52	18.60	1.198	8.92	Barometer reading = 30.06 in. Hg.
23.4	1400	13.65	16.20	1.186	8.96	Rel. humidity = 65%
23.6	1200	11.80	13.80	1.170	9.01	Room temp. = 94°F.
23.5	1000	9.80	11.60	1.182	8.94	
22.8	800	7.60	9.50	1.250	8.74	
20.9	600	5.22	7.10	1.360	8.77	
20.0	400	3.33	4.80	1.440	8.65	
			One-fourth load			
11.2	2000	9.33	17.50	1.875	11.62	Cooling water temp. = 160°F.
11.5	1800	8.62	15.20	1.762	12.28	
11.6	1600	7.72	13.20	1.710	12.60	Barometer reading = 30.04 in. Hg.
11.7	1400	6.83	11.60	1.700	12.53	Rel. humidity = 68%
11.9	1200	5.95	10.20	1.715	12.21	Room temp. = 95°F.
11.7	1000	4.88	8.60	1.763	12.04	
11.4	800	3.80	7.20	1.894	11.52	
10.4	600	2.60	5.40	2.075	11.52	
9.8	400	1.63	4.20	2.575	9.88	

[a] Speedometer miles per gallon.

TABLE 13

Results of tests on variable speeds and loads using gasoline
(1 gallon = 6.1542 pounds at 15°C.)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION			REMARKS
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*mi./gal*[a]	
			Full load			
42.8	2000	35.70	28.40	0.795	6.74	Cooling water temp. = 164°F.
45.8	1800	34.42	26.00	0.757	6.63	
47.0	1600	31.18	22.60	0.722	6.78	Barometer reading = 30.04 in. Hg.
47.5	1400	27.70	19.50	0.703	6.87	Rel. humidity = 80%
48.5	1200	24.25	17.20	0.709	6.68	Carburetor jet No. 45
48.9	1000	20.40	14.70	0.721	6.52	Room temp. = 87°F.
47.4	800	15.80	12.00	0.759	6.39	
46.4	600	11.60	9.40	0.810	6.11	
42.0	400	7.00	6.40	0.914	5.99	
			Three-fourths load			
32.2	2000	26.81	22.00	0.820	8.70	Cooling water temp. = 158°F.
34.2	1800	25.65	20.00	0.779	8.62	
35.2	1600	23.47	17.40	0.741	8.80	Barometer reading = 30.04 in. Hg.
35.6	1400	20.75	14.90	0.718	8.99	Rel. humidity = 77%
36.4	1200	18.20	13.10	0.720	8.77	Room temp. = 88°F.
36.7	1000	15.30	11.20	0.732	8.55	
35.6	800	11.86	9.10	0.767	8.42	
34.8	600	8.70	7.20	0.827	7.98	
31.5	400	5.25	5.60	1.068	6.84	
			One-half load			
21.5	2000	17.92	16.40	0.914	11.68	Cooling water temp. = 158°F.
22.9	1800	17.18	14.90	0.867	11.57	
23.5	1600	15.68	13.30	0.849	11.50	Barometer reading = 30.03 in. Hg.
23.6	1400	13.75	11.50	0.836	11.68	Rel. humidity = 67%
24.2	1200	12.10	10.10	0.834	11.58	Room temp. = 91°F.
24.5	1000	10.20	8.70	0.852	11.02	
23.8	800	7.93	7.30	0.921	10.50	
23.2	600	5.80	6.40	1.101	8.97	
21.3	400	3.55	4.60	1.295	8.32	
			One-fourth load			
10.7	2000	8.91	12.60	1.412	15.19	Cooling water temp. = 162°F.
11.4	1800	8.53	11.00	1.289	15.68	
11.7	1600	7.80	9.80	1.258	15.64	Barometer reading = 30.04 in. Hg.
11.8	1400	6.88	8.60	1.251	15.60	Rel. humidity = 65%
12.0	1200	6.00	7.60	1.268	15.12	Room temp. = 96°F.
12.1	1000	5.04	6.90	1.370	13.88	
11.7	800	3.90	6.00	1.540	12.79	
11.6	600	2.90	5.00	1.722	11.49	
11.5	400	1.917	4.00	2.045	9.60	

[a] Speedometer miles per gallon.

TABLE 14

Fuel economy at fractional loads at 2000 r.p.m. and 1400 r.p.m. using different fuels. With up-draft carburetor

FUEL	LOAD	BRAKE HORSEPOWER		RATE OF FUEL CONSUMPTION IN LB./B.H.P.-HR.		MAXIMUM POWER IN TERMS OF GASOLINE		FUEL CONSUMPTION IN TERMS OF GASOLINE	
		At 2000 r.p.m.	At 1400 r.p.m.	At 2000 r.p.m.	At 1400 r.p.m.	At 2000 r.p.m.	At 1400 r.p.m.	At 2000 r.p.m.	At 1400 r.p.m.
Gasoline	Full load	34.40	26.40	0.785	0.750	100.00	100.00	1.000	1.000
	3/4 "	25.80	19.75	0.728	0.698			1.000	1.000
	1/2 "	17.17	13.18	0.874	0.835			1.000	1.000
	1/4 "	8.57	6.60	1.446	1.212			1.000	1.000
A-Alcohol motor fuel No. 1	Full load	37.00	28.27	1.151	1.068	107.56	107.08	1.340	1.299
	3/4 "	27.72	21.21	1.132	1.102			1.410	1.442
	1/2 "	18.68	14.16	1.329	1.328			1.390	1.451
	1/4 "	9.26	7.04	2.118	1.933			1.336	1.457
A-dehydrated alcohol	Full load	35.41	26.81	1.022	0.961	102.93	101.55	1.223	1.203
	3/4 "	26.50	20.10	1.064	1.003			1.371	1.427
	1/2 "	17.65	13.41	1.257	1.178			1.349	1.128
	1/4 "	8.93	6.70	1.880	1.731			1.220	1.341
A-special motor fuel	Full load	35.59	26.72	1.034	0.991	103.46	101.21	1.221	1.222
	3/4 "	26.69	20.08	1.082	1.035			1.375	1.371
	1/2 "	17.75	13.36	1.293	1.212			1.369	1.342
	1/4 "	8.91	6.65	1.930	1.802			1.326	1.372

TABLE 15

Fuel economy at fractional loads at 2000 r.p.m. and 1400 r.p.m. using different fuels. With down-draft carburetor

FUEL	LOAD	BRAKE HORSEPOWER		RATE OF FUEL CONSUMPTION IN LB./B.H.P.-HR.		MAXIMUM POWER IN TERMS OF GASOLINE		FUEL CONSUMPTION IN TERMS OF GASOLINE	
		At 2000 r.p.m.	At 1400 r.p.m.	At 2000 r.p.m.	At 1400 r.p.m.	At 2000 r.p.m.	At 1400 r.p.m.	At 2000 r.p.m.	At 1400 r.p.m.
Gasoline	Full load	35.70	27.70	0.795	0.703	100.00	100.00	1.000	1.000
	3/4 "	26.81	20.75	0.820	0.748			1.000	1.000
	1/2 "	17.92	13.75	0.914	0.836			1.000	1.000
	1/4 "	8.91	6.88	1.412	1.251			1.000	1.000
A-alcohol motor fuel No. 2	Full load	37.70	27.50	1.047	0.995	105.60	99.28	1.212	1.303
	3/4 "	27.20	21.40	1.168	1.102			1.312	1.414
	1/2 "	19.75	13.41	1.347	1.325			1.358	1.459
	1/4 "	10.30	7.00	1.980	1.957			1.300	1.431
A-alcohol motor fuel No. 3	Full load	37.70	28.40	1.060	0.982	105.60	102.52	1.235	1.294
	3/4 "	29.00	21.30	1.103	1.051			1.246	1.422
	1/2 "	18.75	14.11	1.295	1.240			1.312	1.468
	1/4 "	9.40	7.22	2.045	1.830			1.342	1.450
A-alcohol motor fuel No. 4	Full load	37.50	23.30	1.093	0.995	105.04	102.16	1.285	1.322
	3/4 "	29.18	21.21	1.122	1.067			1.279	1.389
	1/2 "	18.68	14.00	1.332	1.235			1.362	1.380
	1/4 "	10.00	6.70	1.896	1.820			1.254	1.360
A-alcohol motor fuel No. 5	Full load	36.90	28.38	1.172	1.050	103.36	104.26	1.360	1.376
	3/4 "	27.50	21.63	1.207	1.133			1.357	1.454
	1/2 "	18.50	14.40	1.460	1.360			1.474	1.500
	1/4 "	9.25	7.30	2.227	2.010			1.453	1.481
A-alcohol motor fuel No. 6	Full load	37.00	28.85	1.081	0.992	103.64	104.15	1.270	1.316
	3/4 "	28.00	21.65	1.136	1.061			1.294	1.381
	1/2 "	18.50	14.35	1.287	1.198			1.315	1.339
	1/4 "	9.33	7.35	1.930	1.713			1.275	1.279
A-dehydrated alcohol	Full load	36.99	27.40	0.990	0.898	103.61	98.91	1.170	1.199
	3/4 "	27.79	20.52	1.094	1.012			1.253	1.324
	1/2 "	18.50	13.65	1.270	1.186			1.305	1.334
	1/4 "	9.33	6.83	1.875	1.700			1.246	1.276
C-blended fuel No. 2	Full load	37.50	27.70	0.847	0.780	105.04	100.00	1.006	1.046
	3/4 "	28.10	20.82	0.889	0.830			1.024	1.091
	1/2 "	18.75	13.81	1.109	0.983			1.145	1.111
	1/4 "	9.36	6.94	1.580	1.412			1.056	1.066

TABLE 16

Weight of carbon deposit

	B-DEHYDRATED ALCOHOL	A-ALCOHOL MOTOR FUEL NO. 1	GASOLINE
	grams	*grams*	*grams*
Cylinder heads	2.5934	2.5122	4.6376
Piston heads	2.6400	2.4207	4.3641
Piston walls	0.1185	0.2421	0.0961
Piston rings	0.0696	0.0628	0.0351
Ring grooves	0.8513	0.4765	0.3955
Valves	1.0618	0.4668	0.0406
Spark plugs	—	—	0.0659
Total	7.3346	6.1811	9.6349
Relative percentage	76.12	64.15	100.00

TABLE 17

Viscosity of oils used

SAMPLE	130° F.				210° F.			
	1	2	3	Mean	1	2	3	Mean
1. B-dehydrated alcohol 10 hr.	332.0	335.2	334.0	333.7	77.1	76.2	76.6	76.6
2. B-dehydrated alcohol 6.5 hr.	284.2	284.0	281.6	283.3	72.4	70.0	70.8	71.1
3. A-alcohol motor fuel No. 1 10 hr.	320.6	321.4	321.8	321.3	74.8	75.2	75.8	75.3
4. A-alcohol motor fuel No. 1 6.5 hr.	284.6	286.0	282.8	284.5	69.2	69.0	70.0	69.4
5. Gasoline 10 hr.	302.0	305.6	300.4	302.7	74.2	72.8	73.5	73.5
6. Gasoline 6.5 hr.	278.0	276.0	278.2	277.4	69.5	68.6	69.2	69.1
7. Original oil	267.6	266.8	263.2	265.9	67.8	67.8	67.0	67.6

TABLE 18

Piston ring wear

NO. OF CYLINDERS	KIND OF FUEL	COMPRESSION RING 1		COMPRESSION RING 2		SCRAPE RING	
		Weight after test	Loss of weight	Weight after test	Loss of weight	Weight after test	Loss of weight
		grams	*grams*	*grams*	*grams*	*grams*	*grams*
1	Initial	21.8392	--	—	—	18.4950	—
	Dehydrated [a] ..	21.4550	0.3842	22.3357	—	17.4634	1.0316
	Alcohol [b]	21.3517	0.1033	22.2641	0.0716	17.4055	0.0579
	Gasoline	21.2479	0.1038	22.1790	0.0851	17.3104	0.0951
2	Initial	22.1033	—	22.8485	—	18.6760	—
	Dehydrated [a] ..	21.9189	0.1844	22.6478	0.2007	18.4826	0.1934
	Alcohol [b]	21.8303	0.0886	22.5829	0.0649	18.3909	0.0917
	Gasoline	21.7306	0.0997	22.4922	0.0907	18.2820	0.1089
3	Initial	21.8180	—	22.2636	—	17.9133	—
	Dehydrated [a] ..	21.4743	0.3437	21.9677	0.2959	17.5944	0.3189
	Alcohol [b]	21.3921	0.0822	21.8894	0.0783	17.4992	0.0952
	Gasoline	21.2655	0.1266	21.7833	0.1061	17.3890	0.1102
4	Initial	21.7970	—	22.3427	—	18.0683	—
	Dehydrated [a] ..	21.2789	0.5181	22.0172	0.3255	17.7205	0.3478
	Alcohol [b]	21.0707	0.2082	21.8915	0.1257	17.5903	0.1302
	Gasoline	20.8815	0.1892	21.7670	0.1245	17.4743	0.1160
5	Initial	22.0628	—	22.5700	—	18.4600	—
	Dehydrated [a] ..	21.8187	0.2441	22.3207	0.2493	18.1816	0.2784
	Alcohol [b]	21.7276	0.0911	22.2260	0.0947	18.0720	0.1096
	Gasoline	21.5791	0.1485	22.1251	0.1009	17.9624	0.1096
6	Initial	21.8158	—	22.6268	—	—	—
	Dehydrated [a] ..	21.6109	0.2049	22.0732	0.5536	18.2961	—
	Alcohol [b]	21.5206	0.0903	22.0088	0.0644	18.2139	0.0822
	Gasoline	21.3994	0.1212	21.9034	0.1054	18.0954	0.1185
Average ring wear for all cylinders	Dehydrated [a] ..	—	0.3132	—	0.3250	—	0.4340
	Alcohol [b]	—	0.1106	--	0.0833	—	0.0947
	Gasoline	—	0.1315	—	0.1021	—	0.1097
Average percentage of ring wear for all cylinders	Dehydrated [a] ..	—	29.21	—	30.31	—	40.48
	Alcohol [b]	—	38.32	—	28.86	—	32.82
	Gasoline	—	38.30	—	29.74	—	31.96
Relative ring wear with gasoline as 100%	Dehydrated [a] ..	—	238.17	—	318.31	—	395.62
	Alcohol [b]	—	84.10	—	81.58	—	86.32
	Gasoline	—	100.00	—	100.00	—	100.00

[a] Dehydrated alcohol—B-dehydrated alcohol.

[b] Alcohol—A-alcohol motor fuel No. 1.

A REPORT ON THE IMMEDIATE AND RESIDUAL EFFECTS OF AMMONIUM SULFATE FERTILIZER[1]

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In the Philippines corn and upland rice are frequently grown in succession in a field. Dry season corn is planted usually in October and after the crop is harvested the land is fallowed for about 100 days, either plowed or unplowed. In the following rainy season the field is planted to upland rice.

The object of the experiment reported in this paper was to combine this crop practice with the use of ammonium sulfate, a fertilizer known to be beneficial to corn and rice, and to find out whether or not the fertilizer remaining unabsorbed by the corn would increase the rice yield.

The experiments were conducted from October, 1932 to October, 1933 in the fields of the Animal Husbandry Department of the College of Agriculture, Los Baños.

MATERIALS

Variety of corn and rice used. The Native Yellow Flint corn which is grown commercially in this College and in many towns of Laguna was used. The rice used was the Inintiw variety which is considered one of the heaviest yielding varieties of upland rice in Laguna Province. The seed of both corn and rice was furnished by the Department of Animal Husbandry, the rice from the department's 1931 crop. The seed corn was from carefully selected ears of uniform size. It was shelled by hand and dried thoroughly so as to obtain as high a percentage of germination as possible.

Implements. A tractor, a disc plow, a disc harrow, native plows, native harrow, bull cart, Fairbanks portable scale, sickles, winnowing machine and corn sheller were the implements used.

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The land. The land used is clay loam soil. It is well drained. It had been planted to corn for the last four years. The four hectares used were divided into two equal lots. Each lot was in turn subdivided into eight plots, the area of each plot being 2,500 sq. m.

Fertilizer. Ammonium sulfate fertilizer bought from Menzi and Company at 180 Juan Luna, Manila was used.

METHODS

Preparation of the field for planting corn. On August 22, 23, 25, and 26, the field was plowed with a tractor. Because of the almost continuous rain during September and October the field was not plowed a second time until October 13, 14, 19 and 20. The third plowing was on November 14, 16, 17 and 19 and the fourth, on December 1, 2, and 6. Native plows were used in the second, third and fourth plowings. The fourth plowing was necessary because of the long interval between the second and third plowings.

Preparation of the field for planting rice. On April 7, 8, 10, 18, 1933 the field was plowed with a tractor, then disc harrowed. After about a month, on May 10, 11 and 13 the field was plowed for the second time and harrowed. On June 2, 3, and 4 the field was plowed for the third time. The second and third plowings were with a native plow. After the third plowing the field was thoroughly harrowed ready for planting.

The plots. The plots were numbered consecutively from 1 to 16. To avoid as much as possible errors which may be caused by soil variation, the plots were so arranged that each fertilizer treatment could be represented in each lot.

Planting. The corn was planted on December 7, 1932 and the rice on June 12, and 13, 1933. The rows were 100 cm. apart and the hills 80 cm. apart in the row. Four seeds were planted to each hill. On December 22, the young corn plants were thinned to two or three plants to a hill. The rice seed was sown broadcast immediately after the last harrowing of the field, 35 gantas (60.2 kgm.) to a hectare.

Rates and application of fertilizers. The fertilizer was applied at the rates of 50, 100, 150 and 200 kgm. per hectare on December 23, about two weeks after the corn was planted. The fertilizer was applied near the base of the plants in each hill using bamboo measures prepared for the purpose. That is, for the 50 kgm. rate, a bamboo slat measure holding approximately 4 grams of the fertilizer was used as a measure for the fertilizer applied to each hill; a measure holding 8 grams of the fertilizer for the 100 kgm. rate; a measure holding 12 grams for the 150 kgm. rate; and a measure holding 16 grams for the 200 kgm. rate.

Plots 1, 4, 5, and 8 of lot 1 and plots 10, 11, 14 and 15 of lot 11 were used as control. Plots 3 of lot 1 and 13 of lot 11 received fertilizer at the rate of 50 kgm. per hectare; plots 6 of lot 1 and 12 of lot 11 at the rate of 100 kgm. per hectare; plots 2 of lot 1 and 16 of lot 11 at the rate of 150 kgm. per hectare; and plots 7 of lot 1 and 9 of lot 11 at the rate of 200 kgm. per hectare.

Cultivation and weeding. With the corn crop the field was not weeded by hand. It was plowed at intervals of two weeks. It required five days to cultivate the corn, from January 5, 1933 to January 10. The cultivation had to be done slowly to avoid injuring the young corn plants. In cultivating the corn plants the fertilizer which had been applied near the base of the corn plants was covered with soil, which prevented its being washed away when the heavy rains came.

Although the field was thoroughly prepared when the rice was planted, weeding was, nevertheless, necessary. For it was the rainy season and the weeds grew as fast if not faster than the rice plants. Weeding was done from July 4 to 13, 1933. One hundred twenty-nine men-days were required to weed the whole field. In weeding, a trowel-like implement (*dulos*) was used in digging out the weeds, which were gathered and thrown off the field.

Flowering. On January 24, 1933 about 48 days after planting, the corn plants began tasseling. The rice plants began to flower on August 30, 1933 about 80 days after the seeds were sown. It was observed that the corn and rice plants in the different plots did not flower uniformly. For example, the corn and rice plants in the control plots flowered from two to five days ahead of the plants in the treated plots.

Harvesting and shelling the corn. In harvesting, every ear was husked from the standing plant and put in piles. After each treatment was harvested the ears were collected and hauled to the bodega where they were dried for about a week and then shelled.

Harvesting and threshing the rice. The rice was harvested with a native sickle (*pangapas*) from September 29 to October 2, 1933. The plants were cut half way between the tip of the panicle and the base of the plant and were left in thin piles for a few hours. When all the plants were harvested the cut grain in each treatment was piled together, taken to the Animal Husbandry camarin and threshed by hitting the cut rice against empty crude oil drums. The threshed palay was winnowed in a native winnowing machine (*hunkuyan*). The cleaned palay was spread on a concrete floor and left to dry for about two days. The harvest from each plot was then weighed and recorded.

FIELD OBSERVATIONS

Before the fertilizer was applied the writers went to the different plots to make some observations on the stand of the corn plants. It was found that the plants were almost uniform in color of leaves and stems. About twenty days after the application of the fertilizer a noticeable change was observed among the corn plants in the different treatments. For example, the plants of the control and the 50 kgm. treated plots were yellowish green in color, those in the 100 and 150 kgm. treatments were green and those of the 200 kgm. treatment were dark green. Before the corn tasseled, the plants of the 50 kgm. treatment were found to be greener than those of the control plants. Later, in the development of the plants the treated plants were found in general to be taller than the untreated ones.

About two weeks after the rice seeds had been sown broadcast, the rice plants in the different plots exhibited the same degree of green coloring and growth development that the corn plants planted in the same plots had shown the previous season. The plants in the heavier treated plots were also observed to have developed more stools than the control and the lighter fertilized plots.

Only two pests were observed attacking the corn plants. These were the stalk borer (*Pyrausta nubilalis* Hübner) which attacked the stalks of the plants causing them to break when the wind blew; and the corn ear worm (*Heliothis obsoleta* Fabr.) which ate the kernels of the ear. The damage caused by these pests was negligible as the students in Agronomy 13 class numbering about 47 were assigned to collect and kill these pests. The rice plants were attacked by mayas and to a very small extent by the rice smut. But the damage was negligible.

YIELD OF THE DIFFERENT PLOTS

Table 1 shows the yield of shelled corn from the different plots; table 2 the yield of rice from the different plots. Table 3 shows the average yield of corn and rice per treatment per hectare of ground. Table 4 shows the gain or loss per hectare from both corn and rice from each treatment.

COMPARATIVE YIELDS OBTAINED FROM THE DIFFERENT TREATMENTS

It may be seen in table 1 that, in general, the yields of corn were greater in the treated plots than in the control plots. There were only two cases in which the yields of the control plots were greater than that of the fertilized plots. These cases are control plots numbers 5 and 15 which had higher yields than those from plots 3 and 13 which were treated with 50 kgm. of fertilizer per hectare. When the average yield of the 50 kgm. treatment, however, was compared with the average yield of the control plots it was found that the 50 kgm. treatment was 2.34 cavans greater than the control plot (table 3). In table 1 it may also be seen that plot 7 which was fertilized at the rate of 200 kgm. per hectare gave the highest yield of corn; second highest was plot 12 fertilized at the rate of 100 kgm. per hectare; the third highest was plot 2 fertilized at the rate of 150 kgm. per hectare. Plots, 3 and 13 which received only 50 kgm. of the fertilizer per hectare gave the lowest yields of all the fertilized plots.

Referring to table 2 it may be seen that the three control plots 1, 5, and 8 gave higher yields of rice than the two treated plots 3 and 13 which received 50 kgm. treatment. The higher yield obtained from plot 5 which was a control plot may be partly attributed to its being on a lower level than the surrounding plots. Plot 7 which received 200 kgm. of the fertilizer per hectare gave the highest yield.

It may also be seen from the same table that the individual fertilized plot yields of rice in the order of their production are as follows: First, plot 7 which was fertilized with 200 kgm. per hectare; second, plot 6 fertilized with 100 kgm.; third, plot 2 fertilized with 150 kgm.; fourth, plot 16 fertilized with 150 kgm.; fifth, plot 9 fertilized with 20 kgm.; and sixth, plot 13 which was fertilized with 50 kgm.

From table 3 it is evident that with both corn and rice the average yields of the treated plots were in all cases greater than the average yield of the control. The highest average yield, 31.66 cavans of shelled corn and 48.69 cavans of rough rice, was obtained from the application of 200 kgm. fertilizer per hectare. The second highest yield, 30.23 cavans of shelled corn and 47.06 cavans of rough rice per hectare, was from the 150 kgm. treatment; the third highest yield, 30.20 cavans of shelled corn and 44.98 cavans of rough rice per hectare, was from the 100 kgm. rate of application; the fourth highest yield, 22.92 cavans of shelled corn and 35.34 cavans of rough rice per hectare, was from the 50 kgm. treatment; and the lowest yield per hectare, 20.58 cavans of shelled corn and 35.07 cavans of rough rice was from the control plots.

PROFIT OR LOSS RESULTING FROM THE APPLICATION OF THE FERTILIZER

The gain or loss in corn resulting from the application of different amounts of fertilizer was computed by multiplying the difference in yield in cavans of shelled corn between the control and fertilized plots by ₱2.50, the current price of one cavan of shelled corn in the Agronomy Department, and subtracting from the product the cost of the fertilizer, transportation and application. The difference is the gain or loss.

The gain or loss from each treatment from both the corn and the rice crops was obtained by adding the gain or loss obtained from corn to the value of difference in yield of the corresponding treatment in rice. It will be noted in table 4 that gains were obtained from the three highest rates of fertilizer application with corn. The 50 kgm. treatment gave a loss of ₱0.24 per hectare. The gain from the 100 kgm. rate of application was ₱13.87; from the 150 kgm., 9.88; and from the 200 kgm. treatment, ₱9.34.

Using ₱2,00 as the cost per cavan, when the value of the difference in yield of rice from the different treatments was determined it was found that the heavier the rate of fertilizer application the higher was the value of the difference in yield. The value of the difference in yield ranged from ₱0.54 from the 50 kgm. treatment to ₱27.24 from the 200 kgm. treatment. As these values of the difference in yields of rice were obtained as a result of the residual effect of the fertilizer used for corn and as the cost of the fertilizer applied per treatment had been deducted from the value of the difference in yield of corn, the values of the difference in yield of rice may be taken as gain. The gains per treatment from both the corn and rice crops were determined by adding together the gains from the corn and rice crops. These gains may be seen in table 4. The gains ranged from ₱0.30 from the 50 kgm. treatment to ₱36.58 from the 200 kgm. treatment. The 100 kgm. treatment gave a gain of ₱33.69 and the 150 kgm. treatment, ₱33.17 per hectare. These gains are ₱2.89 and ₱3.41 lower than the gain obtained from the 200 kgm. treatment.

SUMMARY AND CONCLUSIONS

1. The effects upon the yield of corn of the application of different amounts of ammonium sulfate fertilizer were studied in these experiments. The experiment on corn was run only during the dry

season planting of corn. The residual effects upon the yield of rice, Inintiw variety, of the different amounts of fertilizer applied on the plots planted to corn were determined by planting the rice in the following rice season on the plots that had been planted to corn.

2. All the treated plots gave higher average computed yields of corn per hectare than the control plots. The control plots gave the lowest average yield, 20.58 cavans of shelled corn per hectare; the 50 kgm. treatment the next lowest, 22.92 cavans; the 100 kgm. treatment, third lowest, 30.20 cavans; the 150 kgm. treatment, fourth lowest, 30.23 cavans and the 200 kgm., the highest, with 31.56 cavans.

3. As with corn, the rice in all the treated plots gave higher average computed yields per hectare than the control. The control gave the lowest average computed yield, 35.07 cavans of clean rice per hectare; the 50 kgm. treatment, gave 35.34 cavans; the 100 kgm. treatment, 44.98 cavans; the 150 kgm. treatment, 47.06 cavans and the 200 kgm. treatment, 48.64 cavans.

4. The three highest rates of fertilizer application; namely, 100, 150 and 200 kgm. per hectare gave gains from corn as follows: ₱9.88 from the 150 kgm. rate of application per hectare; ₱9.34 from the 200 kgm. and ₱13.87 from the 100 kgm. The 50 kgm. treatment gave a loss of ₱0.24 per hectare.

5. With rice, the highest value of the difference between control and fertilized plot in yield, ₱27.24, which, in this case, may be considered gain, was obtained from the 200 kgm. treatment. The next highest gain, ₱23.29, was obtained from the 150 kgm. treatment; the third highest gain, ₱19.82, from the 100 kgm. treatment and the lowest gain, ₱0.54, from the 50 kgm. treatment.

6. When the gains obtained from corn and rice were combined, the highest gain, ₱36.58, was obtained from the 200 kgm. treatment; second highest, ₱33.69, from the 100 kgm. treatment; third highest, ₱33.17, from the 150 kgm. treatment and the lowest gain, ₱0.30, from the 50 kgm. treatment.

TABLE 1

Showing the actual yield of corn per plot and the computed yield per hectare of the different plots, area 2500 sq. m.

PLOT NO.	TREATMENT	WEIGHT OF GRAIN	COMPUTED YIELD PER HECTARE
	kgm.	*kgm.*	*cavans*
1	Control (None)	314.00	21.65
2	150	418.00	28.82
3	50	340.00	23.44
4	Control	277.00	19.10
5	Control	348.00	24.00
6	100	407.00	28.06
7	200	469.00	32.38
8	Control	299.00	20.62
9	200	446.00	30.75
10	Control	297.00	20.48
11	Control	271.00	18.68
12	100	469.00	32.34
13	50	325.00	22.41
14	Control	241.00	16.62
15	Control	341.00	23.51
16	150	459.00	31.65

TABLE 2

Showing the actual yield of rice per plot and the computed yield per hectare of the different plots, 2,500 sq. m.

PLOT NO.	TREATMENT	WEIGHT OF GRAIN	COMPUTED YIELD PER HECTARE
	kgm.	*kgm.*	*cavans*
1	Control (None)	427.00	39.72
2	150	516.00	48.00
3	50	409.00	38.04
4	Control	290.00	26.97
5	Control	538.00	50.04
6	100	570.00	53.02
7	200	580.00	53.95
8	Control	462.00	42.97
9	200	466.00	43.34
10	Control	329.00	30.60
11	Control	357.00	33.21
12	100	397.00	36.93
13	50	351.00	32.65
14	Control	301.00	28.00
15	Control	313.00	29.11
16	150	496.00	46.13

TABLE 3

Showing the average yield per hectare of corn and rice from the different treatments

TREATMENTS	CORN	RICE
	Av. yield per ha.	Av. yield per ha.
kgm.	*cavans*	*cavans*
Control	20.58	35.07
50	22.92	35.34
100	30.20	44.98
150	30.23	47.06
200	31.66	48.64

TABLE 4

Showing the gain or loss per hectare from both corn and rice from the different treatments

TREATMENTS	CORN			RICE			COST OF FERTILIZER & APPLICATION	GAIN OR LOSS FROM	
	Av. yield per ha.	Yield per ha. better than the control and the value		Av. yield per ha.	Yield per ha. better than the control and the value			corn	both
kgm.	*cavans*	*cavans*	*pesos*	*cavans*	*cavans*	*pesos*	*pesos*	*pesos*	*pesos*
Control	20.58	—	—	35.07	—	—	—	—	—
50	22.92	2.34	5.85	35.34	0.27	0.54	6.09	–0.24	0.30
100	30.20	9.62	24.05	44.98	9.91	19.82	10.18	13.87	33.69
150	30.24	9.66	24.15	47.06	11.99	23.29	14.27	9.88	33.17
200	31.66	11.08	27.70	48.69	13.62	27.24	17.36	9.34	36.58

Cost of the transportation of 50 kgm. fertilizer	₱0.34
” ” ” ” ” 100 ” ”	0.68
” ” ” ” ” 150 ” ”	1.02
” ” ” ” ” 200 ” ”	1.36
Cost of application—4 days at ₱1.00 a day	4.00
1 cavan of corn weighs	57.00 kgm.
1 cavan of rice weighs	44.00 ”
Current price:	
per cavan of corn	₱2.50
per cavan of rice	2.00

OBSERVATIONS ON THE EFFECT OF SOME STORMS ON EGG PRODUCTION[1]

F. M. FRONDA
Of the Department of Animal Husbandry

WITH FOUR CHARTS AND ONE MAP

Of the environmental factors that affect the distribution of egg production, perhaps climate is the most important. According to Rice, Hall, and Marble (1930), climate is variable and it embraces within its sphere of influence, either directly or indirectly, other factors in egg production, hence its importance. The chief elements of climate that affect egg production are sunshine, temperature, humidity and wind velocity.

A number of reports on the influence of sunshine and temperature on the distribution of egg production have been published. Among them are Card (1917), Good (1924), Fronda (1928), and Rice, Hall, and Marble (1930). Rice, Hall, and Marble (1930) reported that the results of observations made at Cornell University indicate that humidity has little or no effect on egg production. No study has been made on the influence of the other elements of climate on egg production. But, Rice, Hall, and Marble (1930) stated that, "where the birds are sufficiently protected from the winds by good insulation or windbreaks, either natural or artificial," an ordinary prevailing wind will have little effect upon egg production. Card (1917) also observed that variation in barometric pressure has little, if any, direct effect upon egg production.

Because of the unusually stormy months that the Philippines experienced during the latter part of 1934, exceptional opportunities were presented to observe to what extent a storm, or a series of storms, would influence the distribution of egg production. With the object of adding to the meager information that is available on this subject, the observations made form the subject matter of this paper.

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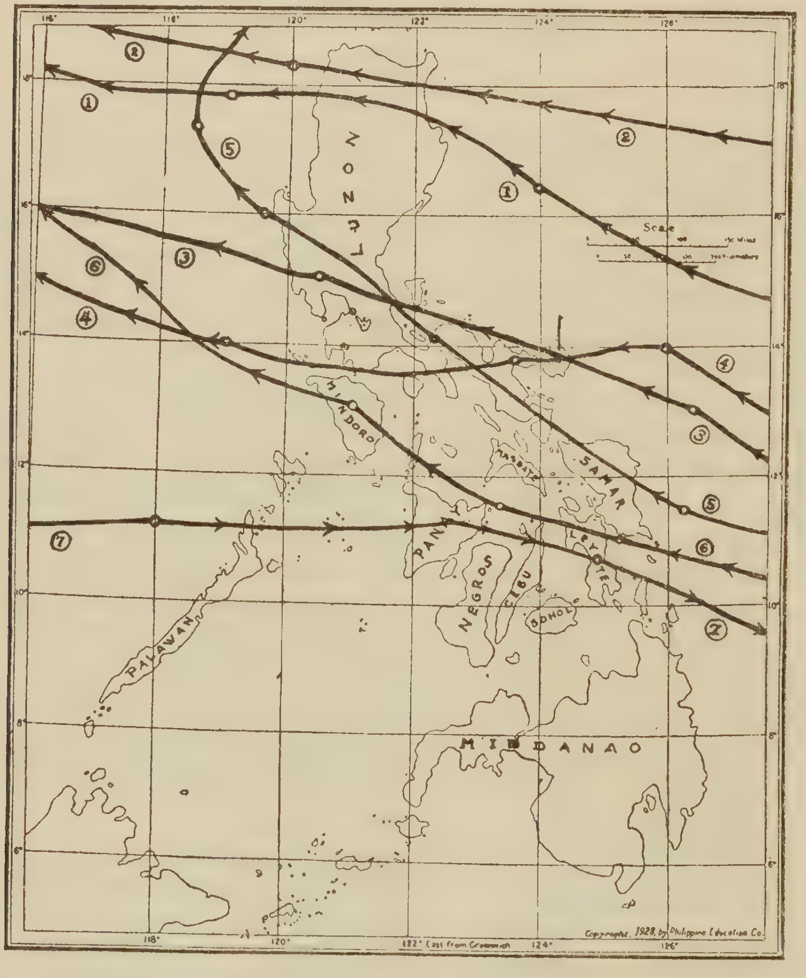
[1] Experiment Station contribution No. 1039. Received for publication March 31, 1935.

A storm, technically speaking, is a wind force of 10 to 11 on Beaufort's scale. This ranges from 56 to 75 statute miles,[2] equivalent to 90.1 to 120.7 kilometers an hour. In this paper, however, a storm was taken in its widest meaning, that is, a disturbance of the atmosphere attended by strong winds, with accompanying rain, thunder and lightning.


116°
118°
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LUZON
MINDORO
MASBATE
SAMAR
LEYTE
PANAY
NEGROS
CEBU
BOHOL
PALAWAN
MINDANAO
Scale
0 50 100 150 Miles
0 50 100 150 200 Kilometers
Copyright, 1928, by Philippine Education Co.
122° East from Greenwich

Fig. 1.—Map of the Philippine Islands showing the paths followed by the seven typhoons which lashed the country in 1934, numbered in the order of their occurrence.

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[2] One statute mile as used in Great Britain and United States is equal to 5,280 feet or 1,609 meters.

There were seven storms that hit the Philippines in the last half of 1934. These, in the order of their occurrence, were: (*a*) September 29 and 30; (*b*) October 3 and 4; (*c*) October 15 and 16; (*d*) October 19 and 20; (*e*) November 14, 15, and 16; (*f*) November 28, 29, and 30; and (*g*) December 4 and 5 (see fig. 1). The third, fourth, fifth, and the sixth storms lashed the "poultry area" covered by this report. Of these, the storm on October 15 and 16 was the severest.

In these observations, egg records from four different poultry establishments were gone over. The help rendered by these farms in supplying the data presented in this paper is here gratefully acknowledged. Another farm was requested to supply data, but it was physically impossible for it to do so as all the laying houses on this farm were unroofed, and the manager's residence suffered a similar fate. All records of the farm were either blown away or so water-soaked, as to be useless.

RESULTS AND DISCUSSIONS

Influence of storm on daily egg production. The percentage daily egg productions of the flocks on the four farms studied are given in table 1 and graphically presented in chart 1. By reference to these, it may be seen that the percentage production of the flocks on each of the cooperating farms decreased only very slightly the day after a storm, and considering that such daily productions are subject to considerable variations even under normal conditions, the decreases registered may be considered nil. The figures on October 14, 15 and 16, and on October 19, 20, and 21 support this observation very emphatically. In one case, flock C, the egg production on the very day of the storm even increased.

Flock B was the worst hit by the storm on October 16; so severely that no record of egg production could be obtained on that day. All laying houses on this farm were unroofed, some were totally demolished, and the chickens were scattered. The egg production on the day after the storm, October 17, however, was only about four per cent lower than that on the day preceding the storm. The egg production of the flock on this farm was not immediately affected; the effect was not noticeable until some days later. Similar effects were observed in the daily egg production of flock A on November 14, 15, and 16, and on November 29, 30, and December 1. This flock was hit by storms also on November 15 and on November 30. From these reports, in general, it may be stated that the daily egg production of a poultry flock is not immediately affected by a storm; the hens lay just as well on a stormy day as on a clear day.

Influence of storm on the egg production curve. The percentages of weekly egg production of the flocks studied are given in table 2 and presented graphically in chart 2. By reference to these, it may be seen that there is a tendency for the egg production to be lower during the two or three weeks after a storm; within a month or thereabouts the egg production returns to normal. This tendency is clearly shown by the average of all the flocks for October 21 and 28, as shown in the last column of table 2.

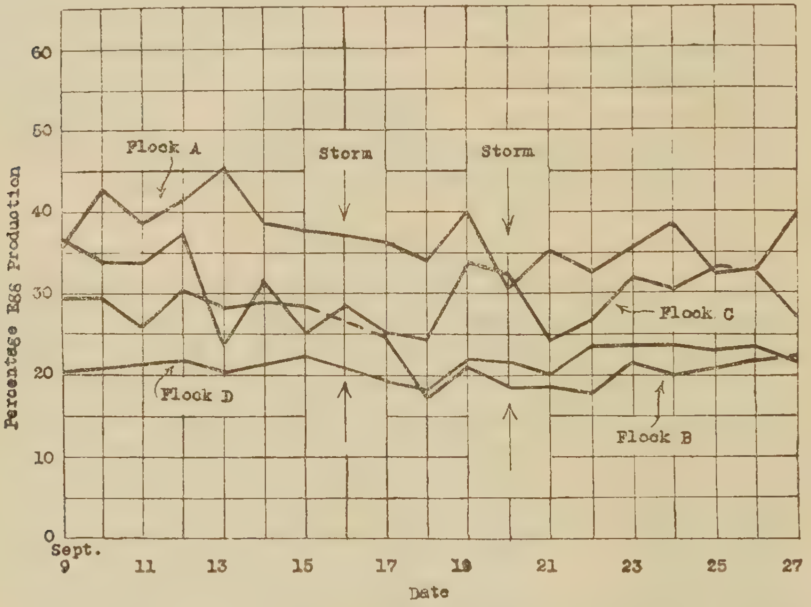

Chart 1.—Curves showing the daily percentages of egg production of the four flocks studied, a week before and a week after a storm, October 9 to October 27, 1934.

The figures for flocks A and C show this tendency very markedly, but flocks B and D do not. In the latter two flocks, a number of pullets that had begun laying during the period under consideration had been added. For instance, flock B had 1085 layers on September 23; there were 1121 on October 28; and there were 1139 from November 15 on to the end of the period observed. Flock D had 1432 layers on September 23, and from October 22, there were 1956 layers.

The distribution of the egg production of flock A was compared with those of comparable flocks in 1932 and 1933. The 1932 and

1933 flocks are comparable with those of 1934 because, like the latter, they were composed of selected pullets that had been hatched during the same season of the year. This distribution of egg production is given in table 3 and graphically shown in chart 3, by reference to which it may be seen that there was a marked tendency for the egg production to decrease after the storms on October 16 and 20. This tendency, however, was not shown after the storms on November 15 and 30. The normal records of comparable flocks in 1932 and in 1933, as may be seen also in chart 3, are very similar. While the 1932 and 1933 flocks increased in their egg production from October 21, the 1934 flock continued to decrease. There is no doubt that this decrease was due to the effect of the storms on October 16 and 20.

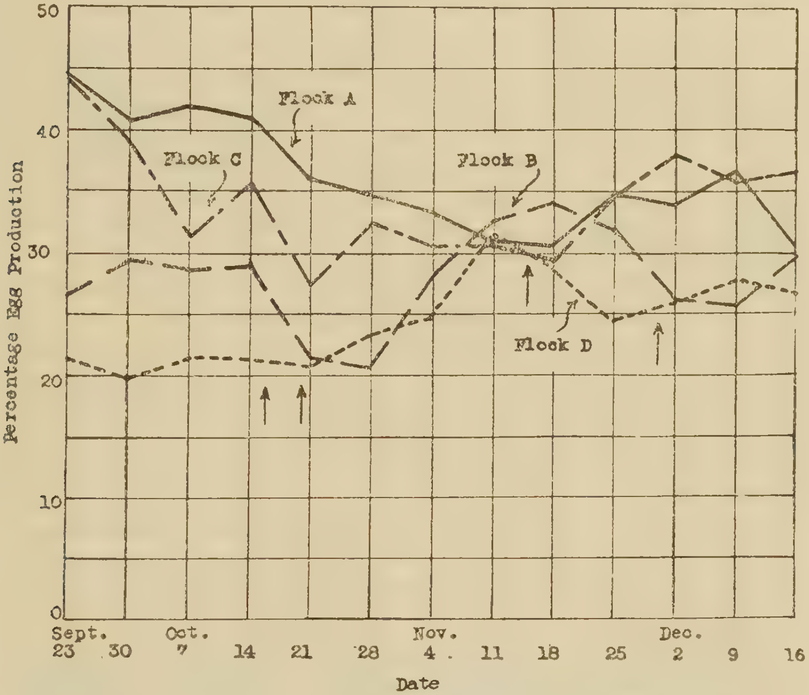

Chart 2.—Curves showing the weekly percentages of egg production of the four flocks studied. Data from September 23 to December 16, 1934. The storms occurred on October 16, 20, November 15, and 30.

The egg production of all flocks, 1932, 1933, and 1934, began to increase from November 18, although that of the 1934 flock was not as marked as that of the 1932 and 1933 flocks. This increase in the egg production of the 1934 flock occurred in spite of the storms on November 15 and November 30. The birds, apparently, had adjusted themselves to the stormy conditions so that regardless of meteorological disturbances they managed to follow the normal curve of egg production. Records after December 16, not given in this paper, show that the egg production curve of the 1934 flock is practically similar to those of the flocks in 1932 and 1933.

Susceptibility of the different breeds to storms. The egg records of different breeds of chickens included in flock A (see table 4 and chart 4) furnish excellent data in determining the degree to which the different breeds suffer on account of storms. The pullets in this flock were hatched the same season and were, therefore, of about the same age. It may be recalled that the storms on October 16, 20, November 15 and 30 hit this flock.

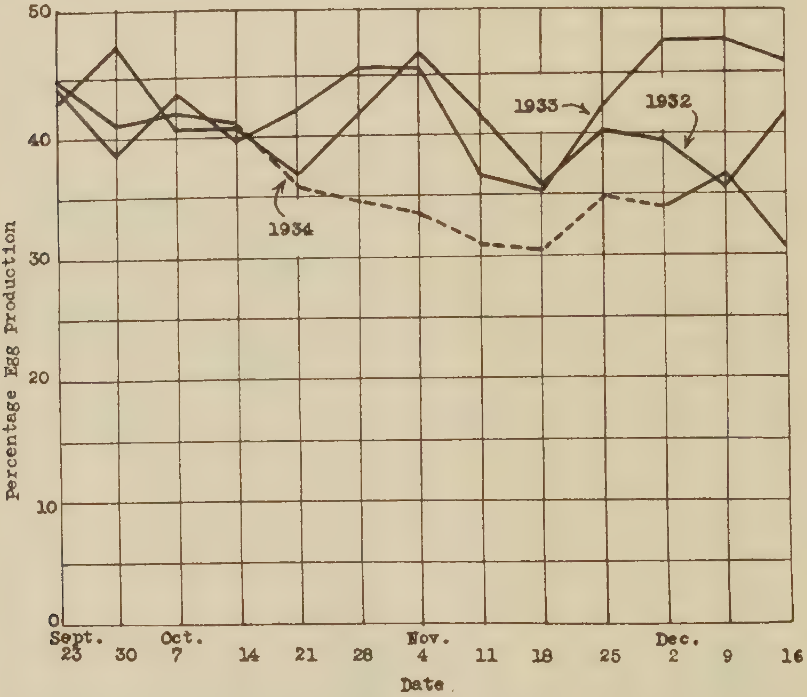

Chart 3.—Curves showing the distribution of egg production of a flock of chickens during a stormy season (indicated by dotted lines). Curves of egg production of similar flocks in 1932 and 1933 are given for comparison.

By reference to table 4 and to chart 4, it may be seen that while a similar tendency was shown by all breeds as to the decrease and the increase in egg production at different periods, the degree of the decrease and the increase differed. The storms on October 16 and 20 caused a sudden fall in the egg production of the Nagoya, S. C. Rhode Island Red, and the S. C. White Leghorn pens, but the Los Baños Cantonese pen maintained its production. It may be seen, also, that apparently the S. C. White Leghorn pens suffered the most, for while the Los Baños Cantonese, Nagoya, and S. C. Rhode Island Red pens recovered their former level of egg production by November 25, and in spite of the storms on November 15 and 30, the curve of the S. C. White Leghorn pens remained far below these three. From these data, it may be concluded that apparently the Los Baños Cantonese pullets were the least affected by the storms, the Nagoya and S. C. Rhode Island Red coming next; the S. C. White Leghorn pullets suffered the most.

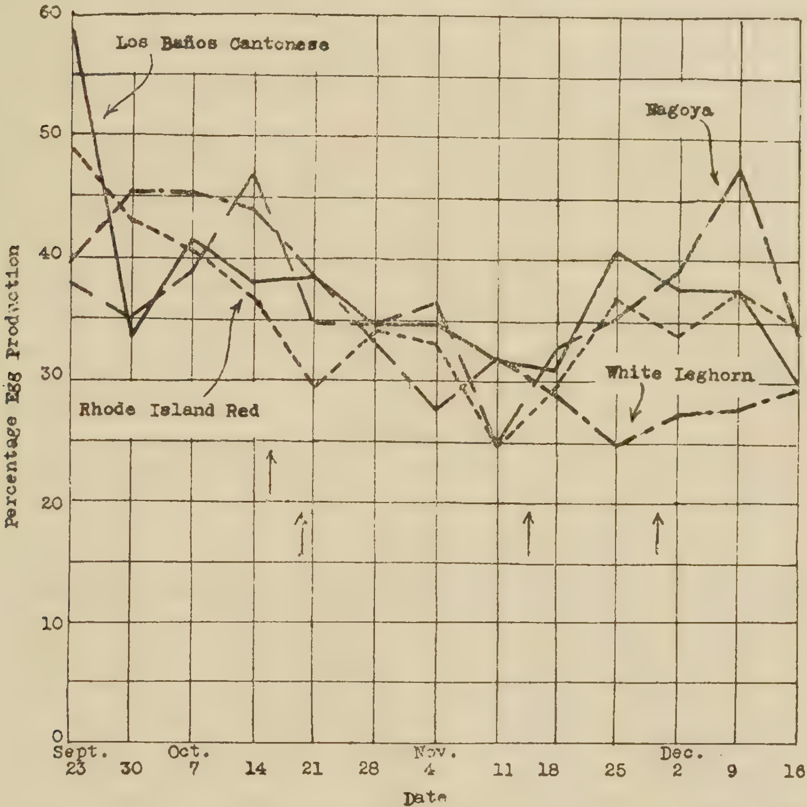

Chart 4.—Curves showing the percentages of weekly egg production of different breeds studied (all from flock A) as influenced by storms. The storms occurred on October 16, 20, November 15, and 30.

SUMMARY AND CONCLUSIONS

Data on egg production during stormy months are presented in this paper. The results of the observations made may be summarized as follows:

1. A storm caused a decrease in the daily egg production of a flock of chickens but this effect was not noticeable until some days after the storm.

2. It was observed that hens lay just as well on a stormy day as on a calm day.

3. The occurrence of a storm caused a depression in the egg production of a flock during the following few weeks, then the egg production returned to normal.

4. It was apparent that the layers are capable of adjusting themselves to stormy conditions so that despite the occurrence of a second storm about a month after the first one, they can manage, at least, to maintain their egg production.

5. It was apparent that the Los Baños Cantonese pullets were least affected by the storms, followed by the Nayoga and S. C. Rhode Island Reds, the S. C. White Leghorn pullets, being the most affected.

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RICE, JAMES E., GOLDAN O. HALL, AND DEAN R. MARBLE. 1930. Judging poultry for production. xii + 425 p., 207 fig. New York: John Wiley & Sons, Inc.

TABLE 1

Showing the daily egg production curves of the flocks on the four farms studied a week before and a week after a storm

DATE	FLOCK A	FLOCK B	FLOCK C	FLOCK D	ALL FLOCKS
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Oct. 9, 1934	36.1	29.3	36.6	20.6	30.41
10, "	43.1	29.5	33.9	20.9	31.86
11, "	38.5	25.9	33.9	21.4	29.92
12, "	41.5	30.6	37.5	22.3	32.99
13, "	45.4	28.2	23.2	20.2	29.25
14, "	38.5	29.0	31.2	21.2	30.00
15, "	37.7	28.5	25.0	22.7	28.48
16,[a] "	36.9	—	28.6	20.9	28.79
17, "	36.1	24.5	25.0	19.0	26.17
18, "	33.8	17.3	24.1	18.1	23.34
19, "	40.0	21.2	33.9	22.1	29.30
20,[b] "	30.8	18.3	32.1	21.6	25.70
21, "	36.1	18.8	24.1	20.1	24.80
22, "	32.3	17.6	26.8	23.4	25.03
23, "	35.4	21.6	32.1	23.9	28.25
24, "	38.8	19.9	30.4	23.7	28.21
25, "	32.3	20.9	33.0	22.9	27.29
26, "	33.1	21.5	33.0	23.4	27.78
27, "	40.0	22.0	27.0	21.7	27.68

[a] Storm hit all flocks, but not very severe on flock A.

[b] Storm hard on flock A but not on the three other flocks.

TABLE 2

Showing the average weekly percentages of egg production of the four flocks studied

DATE	FLOCK A	FLOCK B	FLOCK C	FLOCK D	ALL FLOCKS
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Sept. 23, 1934	44.8	26.8	44.4	21.3	34.33
30, "	41.1	29.5	39.2	19.7	32.38
Oct. 7, "	42.0	28.7	31.6	21.3	30.90
14, "	41.0	29.1	35.5	21.3	31.98
21, "	35.9	21.4	27.5	20.6	26.35
28, "	34.6	20.7	32.3	23.1	27.68
Nov. 4, "	33.5	27.7	30.4	24.8	29.10
11, "	31.0	32.7	30.7	31.4	31.45
18, "	30.4	34.0	29.4	27.8	30.40
25, "	34.8	31.9	34.6	24.5	31.45
Dec. 2, "	33.9	26.1	37.8	26.0	30.95
9, "	36.6	25.6	35.8	27.6	31.40
16, "	30.4	29.7	36.8	26.5	30.85

TABLE 3

Showing the comparative distribution of egg production during stormy and during normal months

DATE	1932	1933	1934 [a]
	per cent	*per cent*	*per cent*
Sept. 23	43.1	44.0	44.8
30	47.5	38.6	41.1
Oct. 7	40.7	43.8	42.0
14	40.7	39.7	41.1
21	37.1	42.2	35.9
28	41.8	45.5	34.6
Nov. 4	46.6	45.4	33.5
11	42.0	37.0	31.0
18	36.0	35.3	30.4
25	40.2	42.6	34.8
Dec. 2	39.3	47.3	33.9
9	35.6	47.8	36.6
16	41.8	45.9	30.4

[a] Stormy year.

TABLE 4

Showing the average weekly percentages of egg production of the different breeds studied (Flock A only)

DATE	LOS BAÑOS CANTONESE	NAGOYA	S. C. RHODE ISLAND RED	S. C. WHITE LEGHORN
	per cent	*per cent*	*per cent*	*per cent*
Sept. 23, 1934	58.6	37.9	48.9	39.5
30, ”	33.2	35.2	42.9	45.4
Oct. 7, ”	41.4	39.0	40.7	45.4
14, ”	38.1	46.7	36.8	44.0
21, ”	38.3	34.6	29.7	38.4
28, ”	34.4	34.6	34.1	33.0
Nov. 4, ”	34.4	36.2	33.0	27.5
11, ”	31.9	24.9	24.7	31.9
18, ”	30.8	33.0	29.7	28.9
25, ”	40.6	35.2	36.8	24.9
Dec. 2, ”	37.4	39.0	33.5	27.3
9, ”	37.4	47.8	37.4	27.8
16, ”	30.0	34.1	34.6	29.3

PUÑGAPUÑG AS A SOURCE OF STARCH AND ALCOHOL[1]

CELESTINO G. REANTASO

INTRODUCTION

Work has been done in the Philippines on a number of tubers and roots such as cassava, sweet potatoes, white potatoes, arrow root, etc. as sources of starch, but little work has been done on the extraction of starch from puñgápuñg. Bacon (1908) reported that the tuber of puñgápuñg is very large yet the highest yield of starch that was obtainable was only 4.5 per cent. And that the presence of numerous spicules of calcium oxalate renders the preparation of an edible starch from this plant very difficult.

Puñgápuñg is a plant growing wild in the Philippines. It bears the botanical name, *Amorphophallus campanulatus* (Roxb.) Blume.

As to characteristics of puñgápuñg, Agcaoili (1916) stated that *Amorphophallus campanulatus* (Roxb.) Blume, tigi in Ilocano and puñgápuñg in Tagalog, is locally very abundant but not cultivated. The young stems when cooked are edible but can not be used raw on account of the minute stinging crystals of calcium oxalate. Tubers are oftentimes used as hog feed.

The possibilities of an alcohol substitute for gasoline as a source of power are being extensively tested at present. In the Philippines, molasses and some palm trees are the present sources of alcohol; with cassava a proved potential source. But these sources are too limited, for if all the molasses at present available in the country were to be used as a source of alcohol the supply would not be enough to meet the demand if alcohol is to replace gasoline as motive power. Search for other possible sources of alcohol is, therefore, imperative.

The work here reported was conducted from July, 1933 to February, 1934 in the Department of Agronomy and in the Department of Agricultural Chemistry.

The objects were to determine: (*a*) the starch content of puñgápuñg; and (*b*) the best condition for the hydrolysis of the starch and its fermentation into alcohol.

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[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 455; Experiment Station contribution No. 1040. Prepared in the Department of Agricultural Chemistry under the direction of Dr. Antonio I. De Leon.

MATERIALS AND METHODS

Puñgápuñg was collected in the vicinity of the College Campus. The proximate chemical composition of the young and old leaves, young and old stems, tuber and pulp was determined. Starch was extracted from the tuber. The extracted starch was hydrolyzed and fermented into alcohol.

Method of analysis

Determinations on moisture, ash, ether extract, crude fiber, protein, carbohydrates, reducing sugars, nitrogen, phosphorous and potassium were made, following the official methods as described in the *Official and Tentative Methods of Analysis* of the Association of Official Agricultural Chemists.

Extraction of starch from the tubers

The tubers, collected in the vicinity of the College Campus, where they grow wild, were washed, peeled, weighed and then grated in College Cassava Grater No. 2. The mixed materials were strained through cheese cloth; the starch passed through the cloth with the liquid. The remaining pulp was soaked in water and strained three times so as to recover as much of the starch as possible.

The filtrate which was collected in petroleum cans was set aside for 2½ to 4 hours and the starch allowed to settle. The water was then decanted and the starch was washed at least three times to remove impurities. After washing, the starch obtained was dried in the sun, then powdered in an iron mortar.

Alcoholic fermentation

Triplicate fifty-gram samples of puñgápuñg starch were treated with 50 ml. of H_2SO_4 solution of three concentrations; namely, one per cent, two per cent, and five per cent acid. These were hydrolyzed in an autoclave (15 lb. pressure) for 2.5 hours at 120°C., to convert the starch into sugars in accordance with the following reaction:

$$(C_6H_{10}O_5)X + H_2O \; \underset{\text{hydrolysis}}{\underline{\quad\text{acid}\quad}} \; C_6H_{12}O_6$$

After hydrolysis the excess acid was partly neutralized with 3 per cent NH_4OH solution, since the yeast required in the conversion of sugar to alcohol is affected by the acidity of the solution and thrives best in a slightly acid medium. Preliminary trials to find the proper concentration of ammonia necessary to partially neutralize the acidity were made before the concentration of ammonia given above was adopted. The samples were then diluted to 1000 ml. and inoculated with pure Fleischmann's yeast. At the end of 24, 48, 72 and 96 hours, respectively, 100 ml. of the fermenting liquid were drawn off and after neutralizing with NaOH solution, distilled for alcohol.

RESULTS AND DISCUSSIONS

Table 1 shows the yield of puñgápuñg starch using College Cassava Grater No. 2. The yield in 11 kilograms of tubers ranged from 4.25 to 4.42 per cent. This yield is low compared with 10.11 to 26.30 per cent obtained from sweet potatoes (Carandang, 1933) and 15 to 40 per cent from cassava (Mendiola, 1931). Table 2 shows the chemical composition of the tuber, leaves and stems of puñgapuñg. The results show that the tuber has a moisture content of 74.93 per cent; ash, .74 per cent; crude fats, .40 per cent; protein, 5.12 per cent; crude fiber, .63 per cent and carbohydrates, 18.18 per cent. Because of the high protein and carbohydrate content, the puñgápuñg tuber may be used to advantage as feed for hogs. Cassava and sweet potato are also utilized as feed for hogs. The protein content of the eight varieties of cassava studied by Adriano, Ramos and Ynalvez (1932) ranged from 0.42 to 2.67 per cent; and the percentage of carbohydrate ranged from 23.21 to 37.28. Of the seven varieties of sweet potato analyzed by these authors the percentage protein ranged from 0.87 to 1.47, and the carbohydrate content from 23.19 to 34.51 per cent. Although the carbohydrate content of puñgapuñg is lower than either cassava or sweet potato, its high protein content would indicate its use as a supplement to either cassava or sweet potato.

The young leaves have a high moisture and protein content, being 87.92 per cent and 3.44 per cent, respectively; the old leaves have a low moisture and protein content, being 84.98 per cent and 2.54 per cent, respectively. The old leaves, however, are high in crude fiber, 7.09 per cent; carbohydrates, 3.25 per cent; and ash, 1.77 per cent, as compared with the young leaves with 4.11 per cent crude fiber; 2.70 per cent carbohydrate; and 1.25 per cent ash. The fat content of both young and old leaves is low.

Both the young and old stems have a fairly high moisture content, being 95.41 per cent and 92.63 per cent, respectively. The other constituents of young and old stems are rather low, except the carbohydrate content of the old stems which is 3.67 per cent. The young stems are used as food for human beings in combination with other vegetables.

After the extraction of starch from the tuber, the portion that is left is the pulp. With a view to utilizing the pulp as stock feed, the proximate chemical composition was determined. The results are given in table 3. The moisture content is 77.35 per cent; ash, 1.83 per cent; fats, 1.53 per cent; protein, 3.69 per cent; crude fiber, 5.13 per cent and carbohydrates, 10.54 per cent. Although the pulp is not high in food value it probably may be used as a stock feed supplement in combination with other feeds.

To determine whether the pulp of puñgápuñg, in addition to being a stock feed, could be used as fertilizer it was analyzed for its nitrogen, phosphorus and potassium content. The results are given in table 4. The pulp gives, on an average, 2.42 per cent N_2, 2.83 per cent P_2O_5, and 0.60 per cent K_2O. These percentages are not very high but they compare favorably in some constituents with:

	N_2 *per cent*	P_2O_5 *per cent*	K_2O *per cent*
Guano	0.5-2	6-20	1-3.6
Copra cake	2.76-3.7	0.7-2.3	2.8-4.2
Lumbang cake	3.3	1.63	0.26

These percentages show that puñgápuñg pulp, a waste product in the making of starch and alcohol, probably can be utilized to supplement expensive sources of nitrogen, phosphorus and potash in the making of fertilizer, as well as to serve as filler in the compounding of certain grades of commercial fertilizers.

Table 5 shows the effect of different acid concentrations in the conversion of puñgápuñg starch to sugar. One per cent acid hydrolysis gave 82.49 per cent glucose; two per cent acid, 84.32 per cent and five per cent acid, 83.63 per cent. There was a little coloration of the sugar noted in 2 per cent acid; this was caused by "humus" formation. With 5 per cent acid hydrolysis the "humus" formation in the sugar increased, as indicated by the dark brown color.

The alcohol content of puñgápuñg starch may be seen in table 6. The percentage by volume and also by weight is given. The table shows that the percentage alcohol, both by volume and by weight, increases from 12.31 to 24.40 per cent by volume, 9.86 to 19.82 per cent by weight and 9.67 to 19.16 grams per 100 ml. up to the third day. On the fourth day a decrease to 21.81 per cent by volume, 17.66 per cent by weight and 17.12 grams per 100 ml. was noted. This decrease, as previously explained, represents the amount of alcohol that is converted into acetic acid. These results indicate that the fermented liquid should be distilled about the third day to prevent loss of alcohol. Hydrolysis with 2 per cent acid shows that the proper time to distill the fermenting liquid is within the second day. From the second day to the fourth day the percentage of alcohol decreases. The decrease is from 15.41 to 12.71 per cent by volume, 12.38 to 10.18 per cent by weight and 12.10 to 9.98 grams per 100 cc.

These yields of alcohol from puñgápuñg starch are lower than that of cassava. Roxas and Manio (1921) reported the yields of alcohol from cassava as 19.60 per cent, 22.43 per cent, 38.08 per cent and 36.40 per cent at the end of 24, 48, 72 and 96 hours, respectively.

A study of table 7 shows that there was a steady increase both in percentage alcohol and acid content up to the third day, after which there was a decrease in percentage alcohol while the acidity increased at the expense of alcohol. This condition existed in one per cent acid hydrolysis.

With 2 per cent acid hydrolysis there was an increase in both percentage alcohol and acid content up to the second day, after which there was a decrease in percentage alcohol, while the acidity increased.

SUMMARY AND CONCLUSIONS

1. The proximate chemical composition of the tuber, leaves, stems and pulp of puñgápuñg was determined. The analysis suggests their use as animal feed to supplement cassava or sweet potatoes.

2. The highest yield of starch obtained using 11 kilograms of tuber was .4862 kilogram or 4.42 per cent. It is not profitable to extract starch from puñgápuñg because of the low yield.

3. One per cent acid hydrolysis puñgápuñg starch without imparting color to the sugar, while partial "humus" formation was noted with 2 per cent, and this darkening of the sugar increased in the case of 5 per cent acid hydrolysis.

4. The highest yield of alcohol obtained was 24.40 per cent by volume, 19.82 per cent by weight, using 1 per cent acid. With 2 per cent acid the highest yield was 15.41 per cent by volume, 12.38 per cent by weight.

5. To prevent loss of alcohol the fermenting liquid should be distilled within the third day in case of 1 per cent acid hydrolysis and within the second day in the case of 2 per cent acid hydrolysis.

6. The pulp of puñgápuñg can probably be utilized to supplement expensive sources of nitrogen, phosphorus and potash and may serve as filler in the compounding of certain grades of commercial fertilizers.

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TABLE 1

Showing the yield of puñgapuñg starch using College Cassava Grater No. 2

NUMBER OF TRIALS	WT. OF TUBERS USED	WT. OF DRY STARCH OBTAINED	YIELD	TIME REQUIRED TO OBTAIN DRY STARCH
	kgm.	*kgm.*	*per cent*	*minutes*
1	10.40	.3536	3.40	132
2	6.20	.2077	3.35	73
3	11.00	.4677	4.25	150
4	11.00	.4776	4.34	155
5	11.00	.4862	4.42	148
6	11.00	.4810	4.37	152
Average	10.10	.4123	4.02	135

TABLE 2

Showing the proximate chemical composition of tuber, leaves and stems of puñgapuñg [a]

MATERIALS	MOISTURE	ASH	CRUDE FATS (ETHER EXTRACT)	CRUDE PROTEIN (N × 6.25)	CRUDE FIBER	N. F. E. CARBOHYDRATE (BY DIFFERENCE)
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Tuber	74.93	.74	.40	5.12	.63	18.18
Young leaves ...	87.92	1.25	.58	3.44	4.11	2.70
Old leaves	84.98	1.77	.36	2.54	7.09	3.26
Young stems ...	95.41	.84	.31	1.19	.82	1.43
Old stems	92.63	.87	.26	.97	1.60	3.67

[a] Results given are average of triplicate determinations.

TABLE 3

Showing the proximate chemical composition of the pulp of puñgapung

NUMBER OF TRIALS	MOISTURE	ASH	CRUDE FATS (ETHER EXTRACT)	CRUDE PROTEIN (N × 6.25)	CRUDE FIBER	N. F. E. CARBOHYDRATE (BY DIFFERENCE)
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
1	77.30	1.83	1.53	3.70	5.12	10.52
2	76.92	1.82	1.52	3.67	5.10	10.98
3	77.20	1.83	1.54	3.69	5.19	10.56
4	76.92	1.84	1.54	3.69	5.21	10.86
5	77.29	1.83	1.53	3.71	5.15	10.49
6	77.82	1.85	1.54	3.69	5.16	10.94
7	77.60	1.82	1.54	3.66	5.20	10.10
8	77.01	1.82	1.53	3.66	5.18	10.76
9	77.62	1.84	1.52	3.70	5.14	10.17
10	77.85	1.83	1.54	3.68	5.08	10.03
Average ..	77.35	1.83	1.53	3.69	5.13	10.54

TABLE 4

Showing the nitrogen, phosphorus and potassium content of the pulp of puñgapung and also of guano, copra cake and lumbang cake

NUMBER OF TRIALS	NITROGEN N_2	PHOSPHORUS P_2O_5	POTASSIUM K_2O
	per cent	*per cent*	*per cent*
1	2.39	2.86	0.61
2	2.41	2.81	0.59
3	2.45	2.84	0.62
4	2.43	2.80	0.58
5	2.40	2.83	0.60
Average	2.42	2.83	0.60
Guano [a]	0.5 –2	6 –20	1.0 –3.6
Copra cake [b]	2.76–3.7	0.7 – 2.3	2.8 –4.2
Lumbang cake [a] ..	3.3	1.63	0.26

[a] Figures furnished by College Experiment Station.

[b] Figures furnished by the Analytical Section, Department of Chemistry.

TABLE 5

Showing the effect of different acid concentrations in the conversion of puñgapuñg starch to sugar

	Wt. of SAMPLE	ONE PER CENT			TWO PER CENT			FIVE PER CENT		
		WT. OF Cu_2O	Wt. of glucose (calc. from table)	Glucose	Wt. of Cu_2O	Wt. of glucose (calc. from table)	Glucose	Wt. of Cu_2O	Wt. of glucose (calc. from table)	Glucose
	grams	*mgm.*	*mgm.*	*per cent*	*mgm.*	*mgm.*	*per cent*	*mgm.*	*mgm.*	*per cent*
	2.00	355.4	165.05	82.52	362.2	168.59	84.29	359.8	167.34	83.63
	2.00	355.3	165.00	82.50	362.3	168.60	84.31	359.7	167.29	83.65
	2.00	355.0	164.86	82.43	362.2	168.59	84.29	359.6	167.24	83.62
	2.00	355.1	164.91	82.45	362.6	168.77	84.38	359.7	167.29	83.65
	2.00	355.5	165.09	82.54	362.4	168.68	84.34	359.5	167.21	83.60
Average ..	2.00	355.3	164.98	82.49	362.3	168.65	84.32	359.7	167.27	83.63

TABLE 6

Showing the alcohol content of puñgapuñg starch hydrolyzed with sulfuric acid and fermented with Fleischmann's yeast

TIME	ONE PER CENT				TWO PER CENT			
	Specific gravity 25/25°	Per cent by vol.	Per cent by wt.	Grams per 100 ml	Specific gravity 25/25°	Per cent by vol.	Per cent by wt.	Grams per 100 cc.
hours								
24	0.98353	12.31	9.86	9.67	.98564	10.59	8.46	8.31
48	0.97858	16.51	13.29	12.96	0.97985	15.41	12.38	12.10
72	0.96950	24.40	19.82	19.16	0.98162	13.91	11.16	10.92
96	0.97255	21.81	17.66	17.12	0.98304	12.71	10.18	9.98

[a] Results are averages of six concordant replications.

TABLE 7

Showing the relation between alcohol content and acid development in the fermenting liquid

	ONE PER CENT				TWO PER CENT			
	24-hour	48-hour	72-hour	96-hour	24-hour	48-hour	72-hour	96-hour
Per cent by volume	12.31	16.51	24.40	21.81	10.59	15.41	13.91	12.71
Per cent by weight	9.86	13.29	19.82	17.66	8.46	12.38	11.16	10.18
Grams per 100 ml.	9.67	12.96	19.16	17.12	8.31	12.10	10.92	9.98
Acidity [a]	1.8	2.4	3.3	4.2	2.1	2.6	3.1	3.4

[a] Acidity expressed in ml. n/10 alkali per 100 ml. of the sample.

RICHARD MORRIS HOLMAN: IN MEMORIAM[1]

It is with deep regret that we learn of the death of Dr. Richard Morris Holman, associate professor of botany of the University of California. Doctor Holman was born in Pittsburgh, Pennsylvania in 1886. He received his A. B. degree from Stanford University in 1907 and his Ph.D. degree from the University of California in 1915.

Doctor Holman first saw service in the Philippines as instructor in botany at the old Philippine Normal School, when this school was the highest government educational institution in the Philippines, giving not only normal training but also junior college and preparatory professional courses for medicine, law and agriculture. He served there for one year and then came to the College of Agriculture where he was senior instructor of botany from June 13, 1910 to June 24, 1912. Thus Doctor Holman was one of the pioneers who helped build up this College.

He left the College on leave of absence for advanced work with Pfeffer in the University of Leipzig where he stayed two years. His research in Germany centered on the behavior of roots grown in air. He fully expected to return to the University of the Philippines at the completion of his studies for the doctorate, but better opportunities kept him in the homeland. After completing his work for the doctorate at the University of California, he went to Michigan as instructor in botany from 1915 to 1917. From 1917 to 1920 he was professor of botany at Wabash College, Indiana. From there he joined the University of California as assistant professor from 1920 to 1926 and associate professor of botany from 1926 to the date of his death.

Doctor Holman taught not only botany but also chemistry in this College, when the faculty was so small for the work on hand that it was necessary to do double duty to carry on the full curriculum. He served in addition as property officer of the College. On his departure, Mr. Edgar M. Ledyard, acting dean of the College at the time, wrote of him as follows:

> Mr. Holman has been a member of the faculty here for two years. During his first year, the undersigned was associated with him in the teaching work of the College. His keenness, scholarly instincts, preparation, and ability to do a high grade of school work are facts as well known to yourself as to the

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[1] General contribution from the College of Agriculture No. 497.

faculty here. Every day association with Mr. Holman has proven that he has high ideals of what a citizen should be. His family relations are such that he will always, without doubt, maintain the high standards that he has already set.

Doctor Holman was best known outside of his immediate circle by the textbooks which he published with Prof. W. W. Robbins; "Elements of Botany" and "Textbook of General Botany." A laboratory manual to accompany the latter book was also prepared in co-operation with Lee Bonar and Lucile Roush, all of the University of California. His books were probably the most widely used for collegiate beginning courses in botany in the United States. This College takes pride in the knowledge that these books had their beginnings in the form of notes used for the first time on this Campus.

The writer had the good fortune of having his first "job" under Doctor Holman when as an undergraduate he was employed as a student assistant in botany. He assisted him in the herbarium as well as in making weather observations. From him he learned valuable lessons of thoroughness and deep interest in the work on hand which he greatly treasures.

Doctor Holman left the College with the College herbarium as the monument of his labors. This he built up with the collaboration of Dean E. B. Copeland.

While in our College, Doctor Holman lived on the Campus with his wife and mother. He was a devoted husband and a dutiful son.

Many members of our present faculty and alumni who were students of Doctor Holman will regret to hear of his death. He is still remembered on the Campus as a brilliant instructor and one deeply interested in his work.

B. M. GONZALEZ
Dean, College of Agriculture

Life's more than breath and the quick round of blood;
It is a great spirit and a busy heart.
We live in deeds, not years; in thoughts, not breaths;
In feelings, not in figures on a dial.
We should count time by heart-throbs. He most lives
Who thinks most, feels the noblest, acts the best.—BAILEY

ABSTRACTS[1]

Observations on the management of pregnant Berkjala sows and on their feeding requirements. ANGEL B. BELANDRES. (*Thesis presented for graduation, 1932, from the College of Agriculture, No. 456; Experiment Station contribution, No. 1041*).—These observations were made to obtain definite information on the feeding requirements of pregnant Berkjala sows cared for under a given set of conditions, to compare the relative efficiency of two College rations for these sows, and to determine the advisability of feeding liberally with limited exercise and pasturage.

Eighteen Berkjala sows, ranging in age from one year to five years, with an average of about three years, were divided into two lots of nine sows each. The sows in lot I received a ration consisting of 20 parts cracked corn, 60 parts rice bran, 15 parts copra meal, and 5 parts shrimps; those in lot II received the same ration, except that 5 parts meat scraps were substituted for shrimps. A mineral mixture, about one per cent in amount, consisting of 40 parts corn cob charcoal, 18 parts lime, 2 parts copperas (ferrous sulfate), and 40 parts common salt was incorporated with the feeds. The nutritive ratios of the rations were 1:5.34 for the shrimps and 1:5.23 for the meat scraps. Each sow was fed individually and observed from the time of breeding until farrowing. The sows were kept in a limited yard during the day and had access at night to a limited grass pasture.

The following results were obtained: The average gain in weight of sows in lot I (shrimps) was 68.39 kgm., or 68.58 per cent more than the initial weight; in lot II (meat scraps), 65.91 kgm., or 70.67 per cent gain. The difference treated statistically was insignificant.

The litters farrowed by sows in lot I averaged 8.77 kgm. in weight; the litters of lot II averaged 6.39 kgm. Lot I litters were significantly heavier than those of lot II; the difference of the means, 2.39±0.639 kgm., was more than 3.7 times its probable error. This difference in favor of lot I could not be wholly attributed to the difference in the rations but was partly due to the difference in the age of the sows.

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[1] Abstracts presented as part of required theme work in English 3a, College of Agriculture.

Basing computation on the amount of feed consumed daily for every 100 kgm. of live weight, lot I consumed 2.2 kgm. feed; lot II, 2.4 kgm. Basing calculations on feed required for a given unit of gain, lot I required 485.61 kgm. feed; lot II, 519.65 kgm.; that is, lot I required 34.04 kgm. (7 per cent) less than lot II. The cost of feed to make 100 kgm. gain for lot I was ₱26.51 and for lot II, ₱28.63, a difference of ₱2.12. To produce 100 kgm. gain, lot I required in the feed 24.28 kgm. of shrimps, costing ₱6.07; lot II, 25.98 kgm. of meat scraps, costing ₱6.76, making the shrimps the more economical feed.

The sows fed attained a weight much above that which is best for successful farrowing; they were inclined to lie down most of the time and fattened more than was desirable. Constipation was observed. The averages of the following items for both lots were: initial or breeding weight, 96.49 kgm.; weight immediately before farrowing, 163.64 kgm.; gain in weight during the gestation period, 67.15 kgm. (66.06 per cent more than initial weight); loss in weight incident to farrowing, 14.58 kgm. (8.9 per cent of the weight before farrowing), of this weight, 7.58 kgm. or 53.4 per cent represented the average weight of litters born; total feed consumption per sow during the gestation period, 337.3 kgm.; daily feed consumption, 2.98 kgm.; daily feed consumption based on 100 kgm. live weight, 2.3 kgm.; and feed consumption for every 100 kgm. gain, 502.63 kgm.

The important conclusions drawn from these observations were: The ration containing shrimps as protein supplement was a little more economical than the ration containing meat scraps. The 18 Berkjala sows gained, on an average, during the gestation period, 67.15 kgm. or 66.06 per cent, representing a feed consumption of about 337.3 kgm. giving an average of 2.3 kgm. per 100 kgm. live weight. The sows weighed, on an average, 8.9 per cent less just after farrowing; of this loss, 53.4 per cent represented the average weight of litters born. Pregnant sows allowed on pasturage should not be fed liberally.

—Abstract by Dennis Molintas

Studies on the feed and feeding requirements of pregnant Berkjala sows. SABAS P. TANGCO. (*Thesis presented for graduation, 1932, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 457; Experiment Station contribution No. 1042*).—The object of the experiment was to determine the relative efficiency for pregnant Berkjala sows of the two rations in use in the College of Agriculture.

Twenty sows were used. They were divided into two sets of two lots each. In each set, lot I received the old College standard ration containing 20 parts corn, 60 parts rice bran and 20 parts copra meal, and lot II, the new or modified College standard ration in which 5 parts of the copra meal were replaced by dried shrimps. The nutritive ratio of the old ration is 1:6.5, of the modified ration, 1:5.3. Both rations contained the same kind and the same amount of mineral mixture; this consisted of 40 parts wood charcoal, 40 parts common salt, 18 parts lime and 2 parts ferrous sulfate. The animals were fed twice daily. The sows had access to a limited grass pasture.

The following results were obtained: Lot II made an average gain in weight of 23.5 per cent more than lot I. By treating the data statistically the results were found to be significant. The litters produced in lot II were 25 per cent heavier than those in lot I. The average number of pigs to the litter was 7.10 in lot I and 8.10 in lot II. The average number of pigs born alive per litter was 6.7 in lot I and 7.8 in lot II. The difference in the average number of pigs born dead in the two lots was not significant. To produce 100 kgm. gain in the weight of the sows, lot II required 550.95 kgm., average of the two sets of feed; this was 20 per cent less than the amount required by lot I. The sows in lot I made an average gain in weight of 43.03 per cent of the initial weight; the sows in lot II made 51.84 per cent gain. The sows in the two lots consumed an average of 2.36 kgm. feed daily which was 2.05 per cent of their live weight. The amount of feed consumed was found to be sufficient to secure the gain desired during pregnancy. The amount of feed consumed and the amount of gain made daily increased progressively up to the time of farrowing.

The sows in lot I were found to be too fat and were disposed to lie down most of the time. Farrowing with these sows was difficult. The expulsion of the pigs at farrowing took a long time. And these sows suffered from caked udder after parturition.

The following conclusions were drawn from the results of the experiment:

1. For pregnant Berkjala sows, the modified College standard ration proved to be more efficient than the old ration.

2. The modified ration was more efficient than the old ration in producing a given unit of gain in weight.

3. The old ration tends to make the sows too fat. To prevent difficulty in farrowing and after parturition the sows should be given limited feed and plenty of exercise by giving them access to pasture.

—*Abstract by C. R. Flor Cruz*

CURRENT NOTES

England and Germany are now the chief consumers of Azorian pines, [pineapples] France and continental Portugal following.

The plant, which is here [the Azores] of the smooth-leaved Cayenne variety, is grown under glass, special beds of fermenting heath or some other mountain shrub being provided. All the plants are brought to blossom at the same time by a process of smoking, the value of which was accidentally discovered many years ago when a carpenter, working in one of the pineapple houses, chanced to set fire to a pile of shavings. To the surprise of the grower, the plants, instead of being spoiled, burst into flower. By this method practically all the plants in a hot-house can be marketed at the same time, many months earlier than formerly. . . . Wrapped in cellophane or packed in excelsior and crated, the fruit is shipped to the European market by a fleet of three vessels owned by the growers. Last year about 2,000,000 pines, worth half a million dollars, were exported.

The National Geographic Magazine, January, 1935

There seems to be a very great deal of controversy in the papers eulogising the use of atebrin against malaria in Ceylon. I cannot get any definite medical statement at present as to whether this is to be recommended for general use or not but it may interest our members if I quote the medical correspondent of the *Morning Post* as follows:—

"Atebrin is one of the modern drugs introduced with great success in certain districts for the treatment of malaria. Both in the Panama Zone and in Assam recent reports on the use of atebrin to prevent the development of malaria have also been encouraging. It is argued that atebrin is superior to quinine in some respects, it is certainly pleasant to take, but some workers have felt that the cost of a campaign to eradicate malaria by means of atebrin is often unduly high. Extensive experience in parts of India and in Central America is, however, available and it would seem that the Ceylon authorities would be supported by most medical experts in the proposed campaign."

The Planter (F. M. S.) April, 1935.

About thirty years ago poultry was dressed in the States by the old dry picking method, which often resulted in many blemishes of the skin. Then the scalding method came into use, by which the appearance of the dressed chicken or turkey was considerably improved and the output per worker increased. In the last few years a new development has taken place, and this is going to supersede all previous achievements. The scalded bird is led through a special wax bath, and afterwards the wax coating, is easily peeled off with all adherent feathers, leaving an exceedingly attractive product which at present sells at a higher price. Furthermore, the labour costs are considerably reduced, and the output of a poultry dressing plant working with the waxing method is greatly increased. *Food Manufacture* (London).

Reprinted in *The Agricultural Gazette of New South Wales*, April, 1935

In Ceylon, there is a considerable industry in making coconut charcoal; the charcoal produced being either sold in the villages for kitchen use; for use in laundries; for conversion into producer gas; or for consumption in smelting works in Colombo.

The Malayan Agricultural Journal, April, 1935

A new source of tanning material has been discovered in Kazakstan, Russia. This is a species of wild growing rhubarb occurring in Western Kazakstan and known to the native population as 'goal.' It has been used for tanning by the native population from time immemorial, and experiments have proved that this plant yields tanning extract of high quality, surpassing the well-known quebracho extract. Tannin is concentrated chiefly in the seeds and roots, which may also be used for tanning and for the production of tanning extract. The petioles of the plant contain citric and oxalic acids which can be extracted in economic quantity. (*Ind. and Eng. Chem. News Ed.*, Vol. XII, No. 22, p. 412, 1934.)

Reprinted in *Tropical Agriculture*, April, 1935

A beneficial insect, we are told at the conclusion of the section of "Economic Entomology," the wasp (*Scolia manilae*, Ashmead) recruited from Los Baños, has been one of the most important factors in saving the Hawaiian sugar industry.

Tropical Life, April, 1935

COLLEGE AND ALUMNI NOTES

The opening convocation was at eight o'clock the morning of June 10, in the Auditorium. Doctor Manresa, Chairman of the Committee on Social affairs spoke briefly on the type of education in the College. Doctor Santos, with examples, illustrated what students, if they wish to do real work in College, should avoid. Dean Gonzalez welcomed the Freshmen pointing out especially that being a student in this College means hard work. Demeterio Santos, a Senior, spoke for the Student Body. He gave a graphic and in part humorous description of College life. Dramatically, he revealed to the Freshmen some characteristics of some faculty members.

One new feature was the welcome, or "Hello Song" to the new students who were seated in a reserved section. With Professor Roa at the piano and Abel Silva and Antonio Ocampo as leaders the singing of this song and the "College Song" and "U. P. Beloved" was with a fine spirit and swing as college singing should be.

The Committee on Social Affairs is to be complimented on a well planned and well carried out Convocation—just one hour long as planned.

Professor Anne Cole of the English Department went to Mindanao for ten days in Summer Recess. She reports that Mrs. Pearl Spencer, teacher of English in the Lanao High School at Dansalan was warm in her praise of "Doctor Research to the Rescue". She said that parts had been given in Dansalan and the reception by the audience was enthusiastic. She stressed the need of more work of a similar nature.

"Doctor Research to the Rescue" was Circular 13—now out of print. It was prepared in different departments in the College under the supervision of the English Department and arranged and revised and presented in 1927 by this department.

Both Mrs. Spencer and Mrs. Douglas, wife of the Principal of the Lumbatan Farm School, asked Professor Cole for additional material for dramatics from the College of Agriculture. They spoke of the high praise given the original dramatic work that had been done here.

Among those from off the Campus in the Convocation audience was Father José Ma. Sánchez from Los Baños. He not only expressed enjoyment of the meeting, but also spoke of the beauty of the Campus which he said reminded him of Eden Park in Cincinnati, Ohio.

The wedding on May 1, 1935 of Miss Purificacion Caguicla '32 and Mr. Juan O. Unite '23 has a special interest as it is the first marriage where both bride and groom were College of Agriculture Alumni. Mr. Unite for some time has been head of the plant breeding work in the Bureau of Plant Industry at Singalong Station. For the past year Miss Caguicla has been employed in the station.

The College Handbook prepared and distributed by the United Evangelical Church of which Rev. Hugh Bousman is Student Pastor is most attractive and contains much useful information in a form for easy reference.

Mr. Felix Gamo, '31, was a recent visitor on the Campus. He came to make observations in the poultry plant of the College. Mr. Gamo is now managing the Ilone 4 J's Poultry Farm located in Balantang, Jaro, Iloilo. This farm is jointly owned by Messrs. Gil, Eduardo, and Carlos Jalandoni. Among the breeds of the farm, recently imported, are the Mahood strain of Rhode Island Reds and the Hanson and British Columbia strains of S. C. White Leghorns.

Mr. Numeriano Cuevas '33, graduate assistant in Department of Engineering, has been appointed as teacher in Bañga Rural High School, Capiz. Mr. Cuevas was granted Certificate in Agricultural Education, March, 1935.

Mr. Hugo B. Fernandez '35 Sugar Technology was a recent Campus visitor. Mr. Fernandez is with the Hind Sugar Company at Manaoag, Pangasinan.

SERVICE OF CHEMISTRY TO AGRICULTURE[1]

The chief business of chemistry in its relation to agriculture has been "to make two blades of grass grow where one grew before". For nearly the last hundred years the fundamental idea has been prevalent that the human race would disappear through starvation. Malthus predicted it, as did also Sir William Crookes, who prophesied we would not be able to grow enough wheat to sustain the human race. But now we hear on all sides that "too much food is being produced at prices too low to maintain the farmers, etc.".

By the extensive research that has been carried on during the past fifty years, the growth of plants as well as animals has been chemically controlled. By balanced rations they have been properly fed and nourished. By breeding, the protein content, the oil content or the starch content of wheat, oats, corn, and other crops have been improved in such a way that their quality for various specific purposes has been greatly improved. Through proper fertilization and controlled conditions of growth, extra yields have been enormously increased.

Likewise the breeding of stock—horses, cattle, hogs, sheep—has been so developed as to produce better horses, better milch or beef cattle, better pork with the proper distribution of fat and lean in the bacon, as well as hens that will have a laying capacity of 300 eggs or more per year.

Not only have these conditions all required their special chemical controls, but both plants and animals have had to be very carefully protected from disease. This protection is a highly specialized field of chemistry in which by the development of various insecticides, germicides, fungicides, bactericides and disinfectants a strenuous warfare is being carried on for the preservation of the plants and animals. As we have seen in the realm of medicine, chemistry is the chief handmaid, as it were, in this never-ending fight....

Farm products as potential raw materials for the chemical industry

Cotton has been for many years one of our principal textile materials and some 17 million bales of 500 pounds each have gone each year into the production of cloth of various kinds and for numerous uses. But even this had to be processed by the chemist, according to certain washing, bleaching and dyeing processes. With the development of the tire industry more of the cotton fiber has gone into cordage for the construction of tires. Some of the poorer cotton fiber known as "linters" went into the manufacture of explosives like nitrated cotton. Now much more of it is being utilized by various synthetic processes for the preparation of rayon and a new type of paints or lacquers such as Duco, and particularly in the plastic industry. Then from the seeds there result hulls and meal utilized as feeds and fertilizers, the cotton seed oil which is used as edible oils, such as salad oils, the hydrogenated products such as Crisco, and for the manufacture of soap, a by-product from which—glycerine—has many uses, particularly as a basic material for the production of explosives (nitroglycerine), medicine, anti-freeze and synthetic resins (glyptal) used in the preparation of enamels and varnishes and plastics.

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[1] Extract from an address by Dr. A. T. Lincoln before the Minnesota Academy of Science. *Science*, November 23, 1934.

Similarly, corn, which was chiefly grown for feed, is now becoming the basis of a larger number of commercial products, such as starch for the textile trade, corn oil, a salad oil, dextrines for paste, corn syrup and many others. Then there is the cellulose of the corn husks and stalks, a potential material for paper pulp and building insulating boards; and the zein of the corn silks, a vegetable protein resembling cellulose, insoluble in water, with potential uses in the plastic industry.

From oat hulls there has been developed an important chemical solvent, furfurol, from which an important type of plastics is prepared in large quantities for the manufacture of victrola records and similar products.

New crops: Levulose, one of the digestion products of sucrose (cane sugar), is a valuable food, one and a half times as sweet as cane sugar. Its use promises marked benefit to the health of mankind as a preventative or a treatment of diabetes. It occurs in many plants and particularly in the weed, the Jerusalem artichoke or wild sunflower, to the extent of 8.64 per cent to 19.47 per cent. The average in Iowa is about 14 per cent and in Minnesota ranges from 6.72 per cent to 10.3 per cent. With breeding, this can be greatly increased, as has been demonstrated. An experimental plant for the production of levulose is in operation at the Iowa State College of Agriculture at Ames, Iowa.

The tung-oil trees are suited for producing paper, and ramie or China grass offers the strongest natural fiber for clothing and paper. The long leaf and loblolly pine in ten years are suited for pulp fiber.

There are large varieties of nut trees, fruit trees, vegetables, sweet potatoes, peanuts and many others, the cultivation of which can be greatly extended for the production of food. By new processes the chemist is busy with research on these new products so as to make them a valuable source of revenue to the farmer and to give him new opportunities by providing him with new crops. This results in broadening the oldtime farming into a new agricultural industry—"the growing of chemicals through biological means and to chemical ends."....

William J. Hale says: Those who would promote the greatest industry that Heaven can ever give to mortal man must rid themselves of all political and fantastic taint; they must envisage here a chemical industry operating biologically for the betterment of society.

The soundest "commercial basis," and the surest road to profit, is low cost of production. There never would have been any economic progress, and the increasing population of the world would have lived in increasing degradation, if in both agriculture and industry the policy of reducing production costs had not been intinctively followed.

The National City Bank of New York Monthly Letter, April, 1934.

Three types of men go to college: those who are willing to be educated, those who want to be educated, and those who are determined to be educated. Nothing, of course, can stop the last group. The middle group, too, seems to be fairly certain to be provided for, but if there is to be a readjustment, the men in the first group had better look out! I suspect that wanting to be educated and determining to be educated must each involve some element of conscious desire to apply education when it is gotten in socially useful ways.—NEWTON D. BAKER

The Daily Princetonian. Reprinted in *What the Colleges are doing,* May, 1933.

Conceit never earns a dividend of promotion. Conscientiousness does.

The Agricultural Student (Ohio)

PRELIMINARY EXPERIMENTS ON THE INOCULATION OF POTTED PLANTS WITH BUÑGA SEEDS[1]

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WITH THREE PLATES

A great deal has been published about the phanerogamic root parasite, *Aeginetia indica* Linnaeus, of the sugar cane. Juliano (1935) recently made a study of the anatomy and morphology of the vegetative as well as the reproductive organs of this pernicious parasite. In his paper, he included a fairly complete survey of the literature on suggested methods for its control. The first investigator to test the possibility of growing this parasite on plants other than the sugar cane was Kusano (1908). He found that by artificially inoculating roots of numerous plants, seed germination was induced, although in a majority of his inoculated potted plants no further development of the young plant parasite was observed. *Selaginella involvens* Spreng. and *Aspidium rhomboideum* Wall. induced seed germination and globular cells were formed two weeks after inoculation; but no further development of these young plants took place even after three or more weeks. Similar results were obtained with *Cryptomeria japonica* Don and *Thujopsis dolabrata* S. & Z. Monocotyledonous plants which Kusano (1908) found to serve as hosts to this parasite, are: *Canna indica* Linn., *Carex Morrowi* Boott[2], *C. transversa* Boott, *C. lanceolata* Boott, *Imperata arundinacea* Cyr. var. *koenigii* (Benth.) Hack., *Miscanthus sinensis* (Anders.)[2], *Oryza sativa* L. (upland form)[2], *Miscanthus sacchariflorus* Hack., *Panicum flumentaceus* Linn., *P. miliaceum* Linn.[2], *Setaria indica* Kunth var. *germanica* Trin., *Zingiber Mioga* Rosc.[2], *Saccharum officinarum* Linn., and *Zea mays* Linn.[2] Of the fourteen other species belonging to Juncaceae, Cyperaceae, Gramineae, Araceae, Liliaceae, Iridaceae, Dioscoreaceae, and Cannaceae, only *Ophiopogon* did not give the required stimulus for seed germination; the seeds in the others germinated two weeks after inoculation. It was further noted that the percentage of germination seemed to be the highest on plants which produced vigorous roots. The ten available dicotyledonous plants

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[1] Experiment Station contribution No. 1047. Received for publication April 11, 1935.

[2] Natural hosts.

belonging to Plumbaginaceae, Araliaceae, Geraniaceae, Rosaceae, Solanaceae, Leguminosae and Compositae all induced germination of the seeds, except where weak development of the roots was evident (*Fatsia* and *Taraxacum.*) It is, therefore, apparent that the stimulus necessary for the germination of *Aeginetia* seed is not peculiar to particular species of plants, but is given by all vigorously developing roots, whether Phanerogams or Vascular Cryptogams.

Bakhuizen van den Brink (1934) added Gleicheniaceae and Ericaceae to the list of hosts reported by Kusano (1908) for the root parasite, buñga.

According to Merrill (1923-1926), this plant parasite is found in most of the provinces of Luzon, Leyte, Panay, parasitizing on roots of various coarse and wild grasses, chiefly at medium altitudes, and it is sometimes a pest in sugar cane plantations at low altitudes. Examination of botanical collections deposited in the Bureau of Science Herbarium, Manila, revealed that this parasite is very common in the Mountain Province. In fact, on July 26, 1934, Mr. Juan P. Tecson [3] of the Bureau of Plant Industry sent to Mr. E. F. Roldan of the Plant Pathology Department, College of Agriculture, a specimen of *Aeginetia indica* Linn. found growing on a *Paspalum* sp.[4] on one of the main paths inside the Bureau's Station in Baguio, Mountain Province. One of the coarse grasses which was found by Dr. Frank C. Gates to be a natural host of this parasite is *Imperata exaltata* Brongn., collected on Mount Cristobal at an altitude of 2,500 feet on May 28, 1914 (College of Agriculture Herbarium Number 9,751).

No report has ever been made locally on the growth of this parasite on plants other than the sugar cane at low altitudes. In this brief paper, the possibilities of some of our common weed species inhabiting our cane fields as well as some of the wild species in the Maquiling area, as hosts for *Aeginetia* will be given. Results of this investigation will be, in the writer's opinion, of interest to those directly connected with the cultivation of sugar cane, and particularly to those engaged in the eradication of this parasite.

EXPERIMENTS AND RESULTS

The idea of the possibility of the parasite growing on potted plants other than sugar cane at low altitudes was brought to the attention of the writer on February 3, 1934 (Juliano, 1935), when Mr.

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[3] Communication supplied to the writer by Mr. E. F. Roldan for which thanks are hereby expressed.

[2] Determination of this species was not possible as the grass died without forming inflorescence after being planted in a pot.

Emiliano F. Roldan submitted for identification a grass (*Paspalum scrobiculatum* Linn.) which had young tubercles of the parasite on its roots. According to Mr. Roldan, he grew *Zingiber officinale* Rosc. (ginger) in pots and inoculated his plants with the seeds of the parasite. In one of his pots *Paspalum scrobiculatum* grew with his ginger; on examination of the root systems of both the ginger and the weed, young tubercles were found on the roots of the weed but not on the ginger.

First experiment. On March 7, 1934, the writer inoculated eight species of common grasses grown in pots with fresh seeds of the parasite obtained through the courtesy of the Calamba Sugar Estate. The cultures were run in quadruplicates, and the pots were placed under the eaves on the north side of the Plant Physiology Building. The plants were watered liberally every day, and observations were made at regular intervals. On March 28, 1934, exactly twenty-one days after inoculation, two pots from each species were examined for the presence of young tubercles. The soil was taken out of the pots and washed with running tap water, care being taken not to injure the root systems. The other two pots for each species were left, and signs of aërial growth of the parasite were noted from time to time. Results of these observations are shown in table 1.

From the data in table 1, it is obvious that in some of the weeds tubercles were formed, whereas in others [*Cynodon dactylon* (Linn.) Pers. and *Panicum flavidum* Retz.] none were found twenty-one days after inoculation. In those species [*Eleusine indica* (Linn.) Gaertn., *Eragrostis amabilis* (Linn.) W. & A., *Paspalum conjugatum* Berg., *P. scrobiculatum* Linn., and *Sporobolus* sp.] on which formation of tubercles were evident on March 28, 1934, the parasite was not able to develop to maturity in some, as *Eleusine* and *Eragrostis*. On the other hand, one of these weeds [*Digitaria corymbosa* (Roxb.) Merr.] which did not exhibit any sign of tubercle formation twenty-one days after inoculation was able to support the growth of the parasite which had produced well developed capsules by October 15, 1934. In this last species, the stimulus for germination is perhaps not so strong as to induce the rapid tubercle formation so peculiar to the other species, and tubercles must have developed later than March 28, 1934 on which date the soil in half of the cultures was examined by the writer. It seems evident from these observations, that while a species was able to give the required stimulus for the germination of the seeds of the parasite within a period of twenty-one days after inoculation, the parasite did not necessarily develop further than the tubercle-stage, and consequently no mature capsules were formed.

The absence of tubercles in some of the inoculated weed species may also be attributed to the use of *Aeginetia* seeds devoid of embryos, as recently reported by Juliano (1935). In this particular instance, therefore, the absence of stimulating substances and subsequent infections should not be wholly relied upon as the sole deciding factor, although the writer took all the necessary precautions to inoculate the roots of the weed plants with an abundance of fresh seeds, and even sowed extra seeds in the trench dug in effecting the inoculation work. Besides, previous and subsequent microscopic examinations of *Aeginetia* seeds as pointed out below revealed that not many are germless, hence, the limited possibility of inoculating only decidedly sterile buñga seeds.

At the time the parasite was in full bloom in a majority of the cultures, photographs were taken (pl. 1, fig. 1-2; pl. 2, fig. 3). A culture from each of *Sporobolus* sp. and *Digitaria corymbosa* is still alive at this writing and both are being taken care of for further observation.

Capsules developing from those cultures wherein the parasite developed to maturity were collected as fast as they matured. Microscopical examinations of the seeds revealed that a majority of them had well developed embryos. Seeds from those capsules were obtained; soon after they were dry, they were inoculated on young cane seedlings (POJ 2878) growing in glass containers. This inoculation was to determine whether or not the seeds produced by the parasite when grown in the weeds used in the experiment would be able to infest cane plants. Four months after inoculation, all the cane plants inoculated with buñga seeds had well developed *Aeginetia* plants, thus clearly demonstrating that mature viable seeds capable of infecting cane plants were produced by the parasite when grown on some of our common weeds in pots under the conditions obtaining in this experiment.

Second experiment. Another more extensive experiment similar to the first one was undertaken by the writer. Under his direct supervision, collections of all weed species growing in cane fields behind the Protestant Chapel, College of Agriculture, Laguna was made on August 8, 1934, with the help of students taking a course in Plant Physiology 2 during the academic year 1934-1935. These weeds were taken to the laboratory and their root systems washed carefully with tap water. Soon after washing, the roots of these weeds were dipped repeatedly in a box containing fresh *Aeginetia* seeds, and then immediately planted in halves of petroleum cans filled with garden soil obtained from the Experimental Garden of the Department of Plant Physiology. Four cans were planted with each species, two of which received once about two grams of Nitrophoska fertilizer. On December 15, 1934 half of the cultures, one fertilized and the other not fertilized, were examined for the presence of tubercles. The plants were removed from the cans and washed with running tap water, care being taken not to injure their root systems. In some cases where the inoculated plants were showing signs of approaching old age, all the cultures were examined. With these exceptions, the other two cans were left for further observations, and examined from time to time for signs of aërial growth of the parasite. Where the cultures showed signs of aërial growth before or on January 18, 1935, these were left intact, and were allowed to grow for further observation. Results of these observations are shown in table 2.

In this second inoculation experiment, six of the weeds used in the first experiment were included; this gave the writer the opportunity to check his first results. *Panicum flavidum* and *Eleusine indica* did not show any parasite, except in one culture of the former where one tubercle was found on December 15, 1934. This species supplied the necessary stimulus for the germination of the seed of the parasite, but so far has not shown the ability to support further development of the *Aeginetia* plant. *Cynodon dactylon* showed the parasite in one of the cultures (unfertilized) with very small, diminutive flowers which withered within about a week after their emergence from the ground, without reaching anthesis, and consequently no normal capsules were developed. In the first experiment, this species did not show any sign of the parasite. With regard to *Paspalum conjugatum* and *P. scrobiculatum* their cultures showed the development of vigorous parasites similar to those obtained in the first inoculation experiment. *Digitaria corymbosa*, however, did not show at this time any sign of the parasite owing, perhaps, to the poor physical condition of the plants inoculated. These were too advanced in their development when planted in cans, hence they died long before the parasite could gain any foothold, a condition not, perhaps, obtaining in the first inoculation experiment. One of the cultures of this species is being kept for further observation.

The other weeds which were inoculated (see table 2) did not favor the development of the parasite, so did not prove to be potential hosts to buñga. These are *Saccharum spontaneum* Linn., *Andropogon aciculatus* Retz., *Imperata cylindrica* (Linn.) Beauv. var.

koenigii (Retz.) Benth., *Digitaria sanguinalis* (Linn.) Scop., *Rottboellia exaltata* Linn. f., *Kyllinga monocephala* Rottb., *Cyanotis axillaris* (Linn.) D. Don, *Commelina benghalensis* Linn., and *Boehmeria nivea* (Linn.) Gaudich. *Rottboellia* showed signs of old age during the early part of November, 1934, and, perhaps, the parasite had no time to develop to full maturity, although examination of the root systems of the plant on December 15, 1934, did not reveal the presence of the parasite.

In this second inoculation experiment two other species of weeds were found to be potential hosts of *Aeginetia;* namely, *Panicum nodosum* Kunth. (pl. 2, fig. 4) and *Panicum patens* Linn. In the latter, the parasite showed development of subterranean reproductive organs on January 18, 1935 when the experiment was closed.

Kusano (1908) found *Imperata arundinacea* Cyr. var. *koenigii* (Benth.) Hack. serving as host of *Aeginetia.* Merrill (1923-1926), however, considers this variety to be the same as our *Imperata cylindrica* (Linn.) Beauv. var. *koenigii* (Retz.) Benth., the plant on which the writer was not able to observe any sign of growth in any of his cultures. This is interesting because it indicates that susceptibility of a plant seems to be influenced by locality.

Third experiment. Because this parasite, *Aeginetia indica,* has been reported as growing wild on some uncultivated lands, and this report is supported by numerous collections in the Bureau of Science Herbarium, Manila, seven plants which grow wild along Molawin Creek, College of Agriculture Campus, were collected and inoculated, on August 8, 1834 as described in experiment 2. The individual species were planted in four cans, and the treatments given them were similar to those followed in the second experiment described in the preceding paragraphs. Signs of aërial organs of the parasite were noted from time to time, and on January 18, 1935, all the cultures which did not show any sign of aërial reproductive organs of the parasite were examined for any presence of subterranean growth. The soil and plants were removed from the cans, and carefully washed with tap water so as to expose the root systems of the plants. Results of the observations are shown in table 3. Those cultures which showed signs of aërial growth of the parasite were not killed, but are being allowed to grow further for future observations.

Of the seven species thus inoculated, only *Colocasia esculentum* (Linn.) Schott (wild form) (pl. 3, fig. 6), *Scleria scrobiculata* Nees (pl. 3, fig. 5), and *Languas pyramidata* (Blume) Merr. showed the presence of well developed parasites. It should be noted, however, that only half of the cultures (fertilized and unfertilized) showed the presence of the parasite on these three species. In *C. esculentum*, the parasite emerged from the ground on December 21, 1934 (unfertilized) and on January 18, 1935 (fertilized); in *Scleria scrobiculata*, the emergence of the parasite (unfertilized) was on December 21, 1934 and fertilized on January 4, 1935. In *Languas pyramidata*, the parasite had well developed subterranean reproductive organs at the close of the experiment in half of the cultures (fertilized and unfertilized). The other species, *Languas brevilabris* (Presl) Merr., *Curcuma longa* Linn., *Homalomena philippinensis* Engl. and *Centotheca latifolia* (Osbeck) Trin., were free from the parasite at termination of the experiment.[5]

DISCUSSION

The one important point of interest which is brought out in this brief report is that some species of weeds used appear not to be natural hosts of the parasite, while others were able to stimulate the germination of the seeds and tubercles were developed, although no mature parasite plants were able to grow from them. Others were able to prove themselves as natural hosts of the buñga. This peculiar behavior of the parasite was brought out by Kusano (1908) in his seed germination experiments of *Aeginetia* wherein he concluded that "contrary to our natural expectation, that the stimulus necessary for the germination of *Aeginetia* seed is not peculiar to a particular species of plants, but is given by all vigorously developing roots, whether Phanerogams or Vascular Cryptogams." In other words, results herein reported, as well as those of Kusano (1908), seem to direct attention to the possibility of growing a species which has proved not to be a natural host of the parasite in infested fields, so as to stimulate rapid germination of the *Aeginetia* seeds without running the risk of producing a mature plant parasite capable of forming mature capsules, provided, that vigorous root systems are characteristic of these plants.

The writer's idea is to secure plants that will cause the seeds to germinate but not to grow to maturity and produce flowers and seeds. In this way the number of seeds in the soil will be greatly reduced, so that, later, the effect of *Aeginetia* will not be felt. However, if cane roots are present among the roots of those weed plants, the parasite can in all probability transfer to the cane roots. In fact, under field conditions where weeds and cane plants are growing side by side, the parasite grows on the canes and not on the weeds, showing a strong preference for the cane as host.

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[5] Some of the cultures reported in experiment 1 were exhibited by the Department of Plant Physiology during the College Exposition (Silver Jubilee), October 10, 1934. A pot containing *Panicum maximum* Jacq. (guinea grass) with blooming buñga plant was also on display; this was inoculated with buñga seeds by Dr. Rafael B. Espino and Mr. F. T. Pantaleon.

The suggestion given above seems to point to the possibility of a method of control of the parasite very similar, if not identical, to that employed in nemathode control known as "trapping." If a sugar cane field heavily infested with *Aeginetia indica* is not planted to canes, but to either one or more weed species on which *Aeginetia* will grow, the parasite may possibly be "trapped," because on some of the weeds given above it will produce at least tubercles and then stop in that stage. If the field is then plowed to turn the plants or weeds under, their roots will be exposed to the sun to dry. As soon as the roots are dry the parasite will perish. In those weeds on which the parasite produced tubercles alone at the time half of the cultures were examined, the presence of the parasite was not detected in the remaining half of the cultures which were allowed to grow until November, 1934, when this parasite should have attained maturity. As to whether this condition of producing only tubercles is temporary, and the parasite may in the future produce strains that will flower on these plants, remains to be determined.

McWhorter (1922), Teodoro (1925) and Roxas (1927) recommended the planting of legumes in infested fields as a means of keeping down the buñga, and that planting of corn or rice and canes should not be done within a period of 18 months. These recommendations were apparently based on the findings of Kusano (1903, 1908) that (1) the parasite requires a monocotyledonous host and (2) that seeds kept dry lose their vitality or germinating power after two years in Japan. One thing, however, that has to be emphasized at this juncture is the report of Bakhuizen van den Brink (1934) citing Dunn and Tutcher (1912) as having found Gleicheniaceae and Ericaceae (a dicotyledonous family) as hosts to this parasite in Kwantung, China. Although Kusano (1908) was able to note stimulative action on the germination of *Aeginetia* seeds with the use of dicotyledonous potted plants, yet the fact that he did not allow his plants to grow for some time in order to give the parasite all possible chance to develop further may throw some doubt on the recommendations given by McWhorter (1922), Teodoro (1925) and Roxas (1927). In the opinion of the writer, it is very important that any crop plants to be recommended as intercrops for the sugar cane should rigidly pass the inoculation tests so that it is known positively that they are not natural hosts to this parasite in one condition.

It would be impractical to suggest turning sugar cane lands that are heavily infested with the parasite into plantations of some kind of annual or perennial weeds, rather than planting them to annual economic crop plants. For this reason further experiments are under way in which annual crop plants are used for "trapping" purposes. If crop plants on which *Aeginetia indica* will grow on their roots but produce only tubercles are found, and especially if it could be proved that the seeds that germinate and produce tubercles only will not form flowers and seeds, the problem of the control of this cane parasite by seed eradication would seem to be solved. At least, the danger from seeds as potential parasites will be removed.

SUMMARY

A series of inoculation experiments of potted wild and weed plants with *Aeginetia* seeds is herein reported. Species which have not been previously reported as natural hosts of this parasite, *Aeginetia indica* Linn., and have been found able to support normal growth of this plant root parasite under the conditions obtaining in this experiment are: *Paspalum conjugatum* Berg., *P. scrobiculatum* Linn., *Sporobolus* sp., *Digitaria corymbosa* (Roxb.) Merr., *Panicum nodosum* Kunth., *P. patens* Linn., *Cynodon dactylon* (Linn.) Pers., *Colocasia esculentum* (Linn.) Schott (wild variety), *Languas pyramidata* (Blume) Merr., and *Scleria scrobiculata* Nees.

Weed species which were found to stimulate germination of the seeds but did not allow the parasite to grow to maturity on them are: *Eleusine indica* (Linn.) Gaertn., *Eragrostis amabilis* (Linn.) W. & A., and *Panicum flavidum* Retz.

Those weeds wherein no development of the parasite was observed are: *Saccharum spontaneum* Linn., *Andropogon aciculatus* Retz., *Dactyloctenium aegyptium* (Linn.) Richt., *Imperata cylindrica* Linn.) Beauv. var. *koenigii* (Retz.) Benth., *Digitaria sanguinalis* (Linn.) Scop., *Rottboellia exaltata* Linn. f., *Kyllinga monocephala* Rottb., *Cyanotis axillaris* (Linn.) D. Don, *Commelina benghalensis* Linn., *Languas brevilabris* (Presl) Merr., *Curcuma longa* Linn., *Homalomena philippinensis* Engl., *Centotheca latifolia* (Osbeck) Trin., and *Boehmeria nivea* (Linn.) Gaudich.

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EXPLANATION OF PLATES

(The photographs were taken by the Photographic Division of the Department of Soils. The writer expresses his gratitude.)

PLATE 1

Fig. 1. Showing the parasite in bloom on *Paspalum conjugatum* Berg. Inoculated March 7, 1934; photographed September 24, 1934.

Fig. 2. Showing the parasite in bloom on *Paspalum scrobiculatum* Linn. Inoculated March 7, 1934; photographed July 31, 1934.

PLATE 2

Fig. 3. Showing the parasite in bloom on *Sporobolus* sp. Inoculated March 7, 1934; photographed September 11, 1934.

Fig. 4. Showing the parasite in bloom in *Panicum nodosum* Kunth. Inoculated August 1, 1934; photographed January 5, 1935.

PLATE 3

Fig. 5. Showing the parasite with nearly mature flowers before anthesis on *Scleria scrobiculata* Nees. Inoculated August 8, 1934; photographed January 5, 1935.

Fig. 6. Showing the parasite in bloom in *Colocasia esculentum* (Linn.) Schott (wild variety). Inoculated August 8, 1934; photographed January 19, 1935.

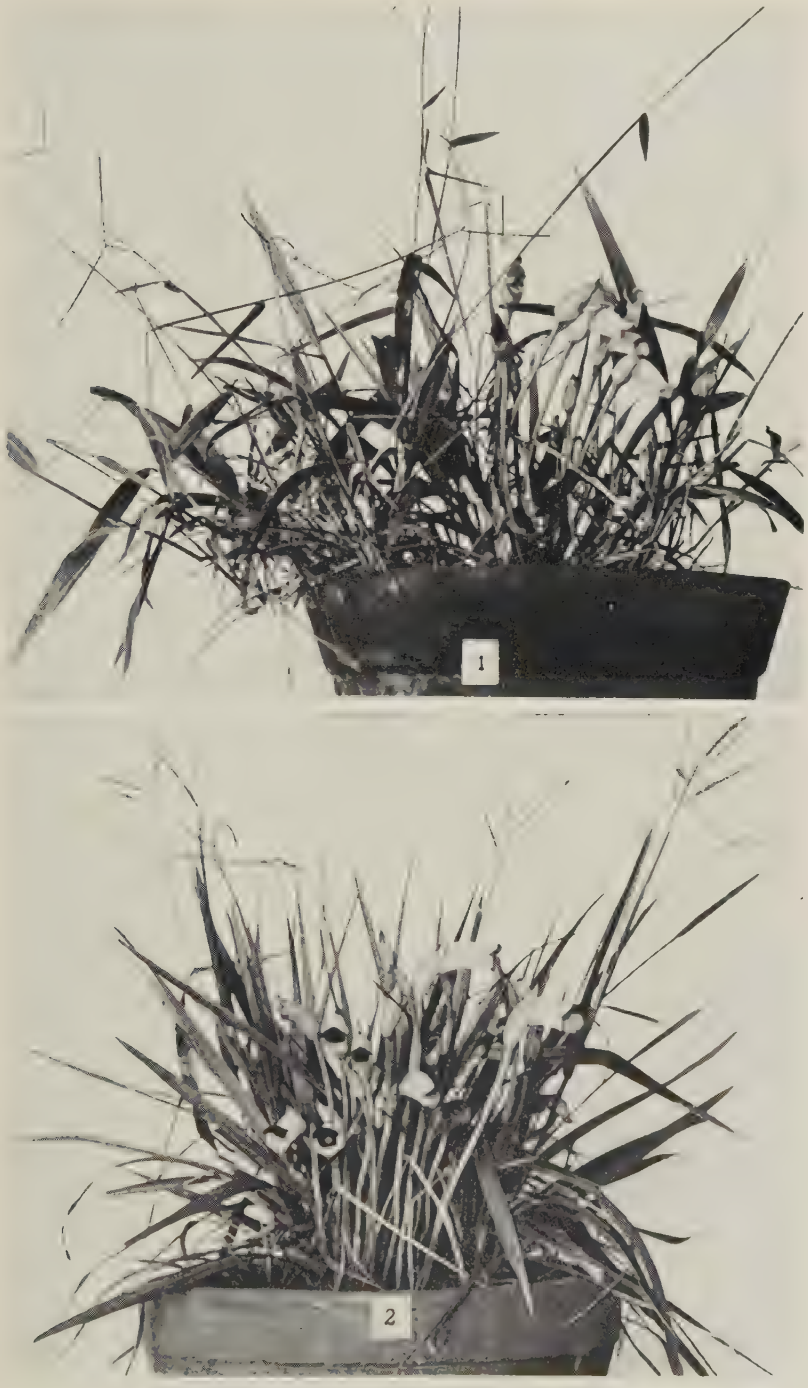

PLATE I

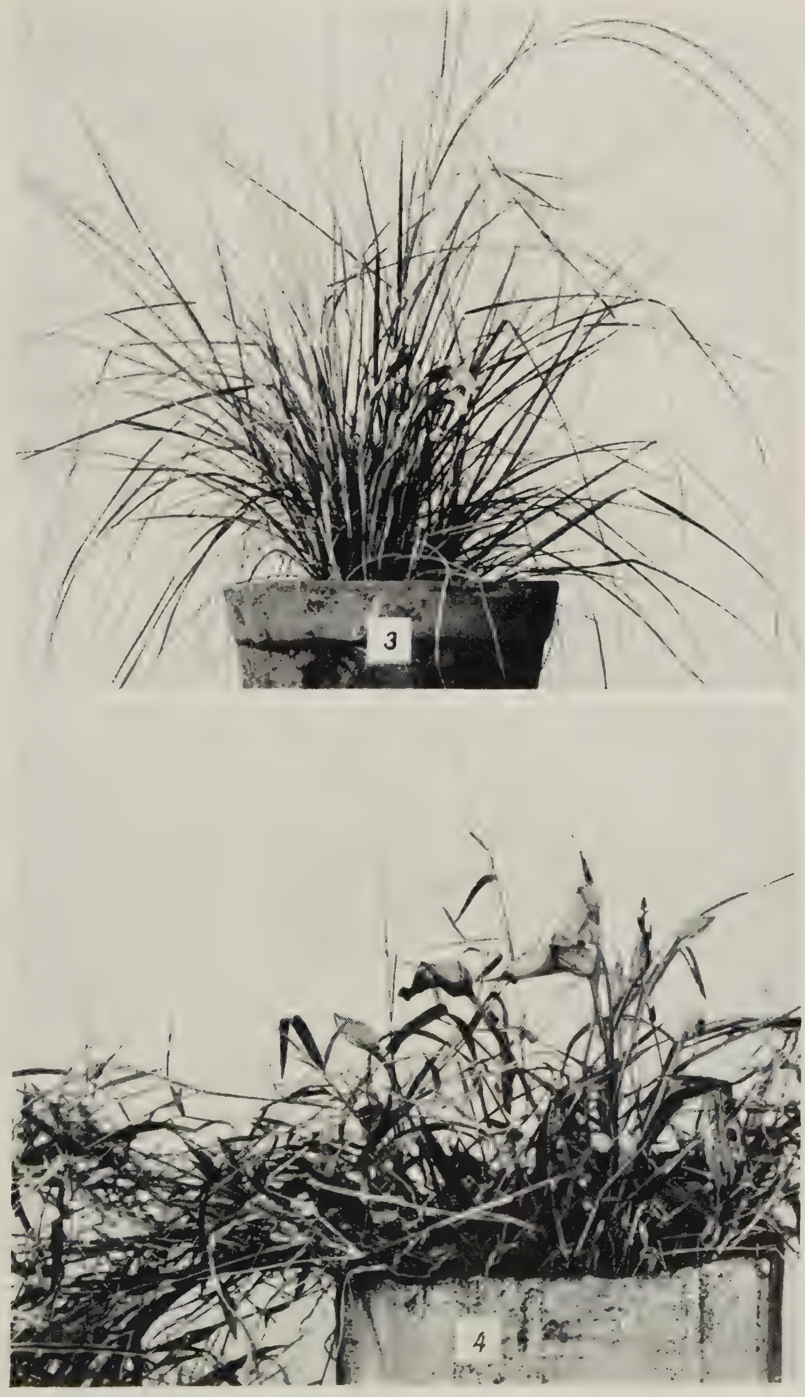

PLATE II

PLATE III

TABLE 1

Showing results of first inoculation experiment of potted plants with Aeginetia seeds [a]

SPECIES	OBSERVATION			
	Root systems examined 3/28/34		Root systems examined or not	
	Culture 1	Culture 2	Culture 3	Culture 4
Cynodon dactylon	No tubercle	No tubercle	Weed dying No parasite, 7/21/34	Weed dying No parasite, 7/21/34
Digitaria corymbosa	No tubercle	No tubercle	Parasite out, 10/1/34 Capsules mature, 10/15/34	Parasite out, 10/6/34 No capsules matured
Eleusine indica	4 tubercles	No tubercle	No parasite, 7/21/34	No parasite, 7/21/34
Eragrostis amabilis	No tubercle	1 tubercle	No parasite, 7/21/34	No parasite, 7/21/34
Paspalum conjugatum	2 tubercles	No tubercle	Parasite out, 8/25/34 Capsules mature, 9/11/34	Parasite out, 8/19/34 Capsules mature, 9/5/34 [b]
Paspalum scrobiculatum	5 tubercles	4 tubercles	Parasite out, 7/13/34 Capsules mature, 8/15/34	Parasite out, 7/10/34 Capsules mature, 8/19/34 [b]
Panicum flavidum	No tubercle	No tubercle	No parasite, 7/21/34	No parasite, 7/21/34
Sporobolus sp.	No tubercle	1 tubercle	Parasite out, 8/16/34 Capsules mature, 9/28/34	Parasite out, 8/10/34 Capsules mature, 9/24/34

[a] Inoculated March 7, 1934.

[b] Pots broken during the typhoon on October 16, 1934.

TABLE 2

Showing results of second inoculation experiment of potted plants with Aeginetia seeds [a]

SPECIES	OBSERVATION				DATE OF OBSERVATION OF ROOT SYSTEMS [c]
	No fertilizer		With fertilizer		
	Culture 1	Culture 2	Culture 3	Culture 4	
Panicum flavidum	No tubercle		1 tubercle		12/15/34
		No parasite		No parasite	1/18/35
Saccharum spontaneum	No tubercle		No tubercle		12/15/34
		No parasite Weed still living *b*		No parasite Weed still living *b*	1/18/35
Panicum nodosum	10 tubercles		8 tubercles		12/15/34
		Parasite out, 12/15/34 No capsules matured *b*		Parasite out, 12/15/34 Capsules mature, 1/18/35 *b*	
Andropogon aciculatus	No tubercle		No tubercle		12/15/34
		No parasite Weed still living *b*		No parasite Weed still living	1/18/35
Panicum patens	No tubercle		No tubercle		12/15/34
		Parasite out, 1/4/35 No capsules matured *b*		No parasite Weed dying, 11/4/34	1/18/35
Digitaria corymbosa	No tubercle		No tubercle	No tubercle Weed dying	12/15/34
		No parasite Weed still living *b*			
Cynodon dactylon	No tubercle		No tubercle	Weed dying No tubercle	12/15/34
		Parasite out, 1/4/35 No capsules matured *b*			
Dactyloctenium aegyptium	No tubercle	No tubercle	No tubercle		12/15/34
				No parasite Weed still living; poor roots	1/18/35

[a] Inoculated August 1, 1934.
[b] Cultures left to grow for further observations.
[c] When no date is given under last column, root systems were not examined.
[d] Dates indicate when root systems were examined.

TABLE 2 (Continued)

SPECIES	OBSERVATION				DATE OF OBSERVATION OF ROOT SYSTEMS *c*
	No fertilizer		With fertilizer		
	Culture 1	Culture 2	Culture 3	Culture 4	
Paspalum scrobiculatum	No tubercle		No tubercle		12/15/34
		Parasite out, 12/21/34 Capsules mature, 1/8/35 *b*		Parasite out, 1/10/35 No capsules matured *b*	
Imperata cylindrica var. *Koenigii*	No tubercle		No tubercle		12/15/34
		No parasite Weed still living; few soft roots		No parasite Weed still living *b*	1/18/35
Paspalum conjugatum	No tubercle		No tubercle		12/15/34
		Parasite out, 12/21/34 No capsules matured *b*		Parasite out, 12/21/34 Capsules mature, 1/18/35 *b*	
Eleusine indica	No tubercle	No tubercle		No parasite	12/15/34
			Weed dying No parasite		1/18/35
Digitaria sanguinalis	No tubercle	Weed dying No parasite	Weed dying No parasite		12/15/34
				No parasite Weed still living *b*	
Rottboellia exaltata	Weed mature, dying No parasite	Weed mature, dying No parasite	Weed mature, dying No parasite	Weed mature, dying No parasite	12/15/34
Kyllinga monocephala	No tubercle		Weed dying No tubercle	Weed dying No tubercle	12/15/34
		No parasite Weed still living			1/18/35
Commelina benghalensis d	Weed dying, 12/15/34 No parasite	Weed dying, 1/18/35 No parasite	Weed dying, 12/15/34 No parasite	Weed dying, 12/15/34 No parasite	
Cyanotis axillaris d	Weed dying, 12/15/34 No parasite	Weed dying, 1/18/35 No parasite	Weed dying, 12/15/34 No parasite	Weed dying, 12/15/34 No parasite	
Boehmeria nivea	No tubercle		No tubercle		12/15/34
		No parasite Weed still living		No parasite Weed still living *b*	1/18/35

TABLE 3

Showing results of third inoculation experiment of potted plants with Aeginetia seeds[a]

SPECIES	OBSERVATION			
	No fertilizer		With fertilizer	
	Culture 1	Culture 2	Culture 3	Culture 4
Colocasia esculentum (var. wild)	No parasite	Parasite out, 12/21/34 Capsules mature, 1/25/35[b]	No parasite	Parasite out, 1/18/35[b]
Languas pyramidata	No parasite	Young inflorescence in ground	No parasite	Young inflorescence in ground
Languas brevilabris	No parasite	No parasite	No parasite	No parasite
Scleria scrobiculata	No parasite	Parasite out, 12/21/34 Flowering, 1/18/35[b]	No parasite	Parasite out, 1/4/35[b]
Curcuma longa	No parasite	No parasite	No parasite	No parasite
Homalomena philippinensis	No parasite	No parasite	No parasite	No parasite
Centotheca latifolia	No parasite Poor plant	No parasite	No parasite	No parasite

[a] Inoculated August 8, 1934; root systems examined January 18, 1935.

[b] Cultures left to grow for further observations; root systems not examined.

EXPERIMENTS ON HARVESTING OF SUGAR CANE (SACCHARUM OFFICINARUM LINN.)[1]

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Harvesting the cane is the most laborious and most expensive operation in the production of sugar cane. It has been reported in some countries that the cost of this operation alone exceeds that of land preparation, planting and cultivation combined. Recently, it was found by Catambay and Segovia (1933) that in the College of Agriculture harvesting was the most expensive operation in the production of sugar cane. They reported the cost to be ₱73.21 a hectare for plant cane and ₱35.26 for ratoon.

With the present limitation of sugar production and the low price of sugar it is very necessary that efforts be made to reduce the cost of production. Any method which will reduce the cost of harvesting and minimize the losses incurred in this operation will help to do this. The present study was conducted with the object of determining the effects of different treatments at harvesting upon the yield of sugar cane.

As the paper by Alincastre (1926) includes a fairly complete review of literature on harvesting of cane, only that literature which has a direct bearing on the special subject under study will be referred to in this paper.

The usual practice in harvesting sugar cane is to top the cane for points, cut the stalk, and haul them to the mill. At times the hauling of the cane is delayed owing to scarcity of labor or unfavorable weather conditions and the cane is left in the field either topped and standing or topped, cut, and lying on the ground for varying lengths of time before it is milled. Westly (1931) stated that tests made in the principal sugar regions all over the world, including the Philippines, showed that the amount of available sugar is reduced at an alarming rate as the time between the cutting of the topped cane and the milling increased. He estimated that 2.5

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per cent of the available sugar is lost when the cane is left cut 3 days before milling; if left 4 days, 12.5 per cent or more of the available sugar originally present in the cane is lost.

Oftentimes the cane is burned either purposely or accidentally and in some of the large fires it may be from 5 days to 2 weeks before all the burned cane can be harvested. Burning the cane before cutting facilitates harvesting and reduces the cost of the operation, and for varieties with heavy trash it is almost necessary. It is believed that this treatment does not cause deterioration in the cane providing that it is milled within 24 to 48 hours. Certain centrals in the Philippines, however, penalize burned canes as much as 4 to 5 per cent because of the loss in sugar sustained and because of the trouble produced in the treatment of the juices.

The work reported in this paper was performed from March, 1932 to April, 1934 in the Experiment Station of the College of Agriculture, University of the Philippines.

MATERIALS AND METHODS

Experiment 1. A preliminary determination of losses caused by delayed harvesting of sugar cane. In this experiment a portion of a cane field planted with mixed varieties of Luzon White and Pampanga Red was used. The canes were plant canes. The experiment was conducted when the canes were 12 to 13 months old or at maturity. The canes did not flower at maturity because in this locality the varieties Luzon White and Pampanga Red do not flower. The selected plot was divided into lots and the different lots were treated as follows: Lot A, the canes were topped on March 3, 1932 and allowed to stand in the field until harvested and analyzed on March 8, 1932; lot B, the canes were topped, the trash burned and the canes allowed to stand in the field until harvested and analyzed on March 8, 1932; and lot C, or control, the canes were harvested and analyzed immediately after they were topped on March 8, 1932.

In all of the experiments the composite cane samples from the different lots or treatments were harvested and crushed separately in the College sugar cane hand mill. A composite sample of the crushed juice from each treatment was analyzed and the degree Brix and per cent polarization were determined. From these data the apparent purity and piculs sugar per ton cane of each treatment were determined by the use of Warren's table and the *Chemical Control for Sugar Factories* published in 1921 by the Association of the Hawaiian Sugar Technologists.

Experiment 2. A detailed study of the effects of the different treatments at harvesting upon the yield of sugar cane. In this experiment a portion of a cane field planted to N.G. 24-B was used. The canes were plant canes and did not arrow at maturity or at the age of 12 to 13 months. The plot was divided into lots and the canes in each lot were given different treatment on March 10, 1932. Analyses of the canes were made at 2 to 3 days intervals. The lots were treated as follows: Lot A, the canes were topped on March 10, 1932 and allowed to stand in the field until harvested and analyzed; lot B, the canes were topped and cut on March 10, 1932 and allowed to lie in the field until analyzed; lot C, the canes were topped, cut, and covered with trash on March 10, 1932 and allowed to lie in the field until analyzed; lot D, the canes were topped and the trash burned on March 10, 1932 and the canes allowed to stand in the field until harvested and analyzed; lot E, the canes were topped, the trash burned and the canes cut on March 10, 1932 and allowed to lie in the field until harvested and analyzed; lot F, the canes were topped, the trash burned, the canes cut and covered with trash on March 10, 1932 and allowed to lie in the field until analyzed; lot G, or control, the canes were topped and harvested immediately.

When the canes of one lot or treatment were harvested and analyzed, corresponding canes of the other lots or treatments were also harvested and analyzed.

Experiment 3. Further studies on the effects of different treatments at harvesting upon the weight of cane and piculs sugar per ton cane. In experiments 1 and 2, only the effects of different treatments at harvesting upon the piculs sugar per ton cane were determined. In this experiment it was desired to find the effects of different treatments at harvesting upon the weight of cane and piculs sugar per ton cane. For this purpose a plot with an area of 588 sq. m. and planted with POJ 2878 sugar cane variety was used. This is an early and profusely flowering variety of sugar cane. The experiment was conducted when the canes were about 13 to 14 months old. The plot was divided into three lots and the different lots were treated as follows: Lot A, the canes were topped on March 19, 1934 and allowed to stand in the field until harvested and analyzed; lot B, the canes were topped, cut on March 19, 1934 and allowed to lie in the field until analyzed; and lot C, or control, the canes were topped, harvested, weighed and analyzed immediately.

The canes of the different lots were analyzed at different intervals. When canes of one lot or treatment were analyzed corresponding canes of the other lots were also analyzed.

RESULTS AND DISCUSSION

Experiment 1. Preliminary determination of losses caused by delay of harvesting sugar cane. The results of this experiment are presented in table 1. The table shows the effects upon the yield of sugar cane of delayed harvesting of topped, standing and topped, burned, and standing canes. It may be seen in table 1 that the samples of canes used in all of the treatments including the control, were uniform and the weather conditions during the test were such that no appreciable changes took place in the canes as shown by the fact that the analyses of the different samples of similar treatment were practically identical. The results show that when the cane was harvested 5 days after topping there was a decrease in the apparent purity of the juice and in the piculs sugar per ton cane. The decrease in apparent purity and piculs sugar per ton cane was even greater when the cane was harvested 5 days after topping and burning, thus showing that the heat generated by the fire destroyed a great quantity of the sugar which resulted in a much lower apparent purity of the juice and piculs sugar per ton cane.

It may be seen in table 1 that when harvesting was delayed 5 days after topping, there was a slight increase in the density of the juice, but a slight decrease in the percentage of polarization resulting in a slight decrease in the apparent purity of the juice. The average apparent purity was 2.225, while in the control it was 2.267. When the cane was topped, burned and allowed to stand in the field for 5 days there was a slight decrease in the density of the juice, but a very marked decrease in the percentage of polarization, resulting in a very marked decrease in the apparent purity of the juice. The average apparent purity was 75.6 and in the control, 91.5. When harvesting was delayed 5 days after topping there was a total loss of 1.8 per cent of piculs sugar per ton cane or at the rate of 0.36 per cent per day. When the cane was topped, burned, and allowed to stand in the field, the loss in weight of piculs sugar per ton cane at the end of 5 days amounted to an average of 32.1 per cent or 6.42 per cent a day. These results corroborate the finding of Locsin (1923) who reported that in 5 days, burnt cane lost 26.47 per cent sugar.

Experiment 2. A detailed study of the effects of the different treatments at harvesting upon the yield of sugar cane. The results of this experiment are presented in table 2. The table shows the effects upon the sugar content of the cane of delayed harvesting of topped, standing; topped, cut; topped, cut, covered; topped, burned standing; topped, burned, cut; and topped, burned, cut, covered canes.

It may be seen in table 2 that during the experiment changes took place in the cane that were due probably to weather conditions; at least the analysis of the juice of the control so indicated. It will be noted that as the experiment progressed there was an increase in the apparent purity of the juice and piculs sugar per ton cane of the control. The analysis of the juice of the control on March 11, 1932 gave an apparent purity of 86.9 and 2.377 piculs sugar per ton cane while analysis made on March 23, 1932, 13 days later, gave 91.3 apparent purity and 2.628 piculs sugar per ton cane.

Losses due to different treatments. The results show that, on the whole, there was a gradual drop in the apparent purity and in the piculs sugar per ton cane, that was due to the different treatments. It may be seen in table 2 that while the apparent purity and piculs sugar per ton cane of the control increased as the experiment progressed, in the treated lots they decreased in varying degrees. The results also indicate that when the cane was harvested one day after the different treatments there was no appreciable gain or loss in the weight of sugar that was due to the treatments. Alincastre (1926) stated that information on burned cane in general showed that juices from cane milled within 24 hours after burning are just as good, sometimes better, than those from unburned cane.

It may be seen in table 2 that at the end of 4 days there was a gradual drop, due to the different treatments, in the apparent purity and in piculs sugar per ton cane. It is interesting to note that unburned, cut canes, whether exposed or covered, and unburned, topped, standing canes showed less loss than the burned, topped, standing canes. At the end of 4 days, the canes that were topped, cut and left exposed in the field, and canes topped, cut and covered gave the greatest loss in piculs sugar per ton cane; it amounted to 15.2 and 14.9 per cent, respectively. The canes that were topped, burned, cut and laid exposed, and those, topped, burned, cut and covered did not show appreciable changes after 4 days, the loss amounting to only 3.2 and 1.1 per cent, respectively. At the end of 4 days, topped canes and topped, burned canes that were allowed to stand in the field showed a loss of 2.4 and 6.2 per cent sugar, respectively.

It may also be seen in table 2 that at the end of 6 days the canes that were topped, cut, laid in the field, and topped, cut, and covered canes showed the greatest loss in piculs sugar per ton cane; it amounted to 22.2 and 27.7 per cent, respectively. The topped, cut, burned and covered canes lost 5.7 per cent, while the topped, burned and cut canes showed an increase of 1.9 per cent piculs sugar per ton cane. It is of interest that after 6 days no appreciable change was noted in topped, standing canes, and topped, burned standing canes; these results do not confirm the results obtained in the first experiment where it was found that after 5 days burned canes showed a loss of 32.1 per cent sugar. According to Henry (1929) Lee found that the losses sustained by the cane after the cutting vary to quite an extent with the weather, the rains accelerating them.

All the treatments at the end of 8 days had produced appreciable losses in the sugar content of the cane. The topped, cut, and laid canes, and topped, cut, and covered canes showed the greatest loss, with 21.4 and 31.3 per cent, respectively. The topped, burned, standing canes showed a loss of 15.9 per cent. The topped, burned, cut covered and the topped, burned, cut canes showed losses of 8.7 and 2.3 per cent, respectively, and the topped, standing cane, 3.9 per cent.

All the treatments at the end of 11 days gave very marked losses in the sugar content of the cane. The greatest losses were again observed in topped, cut, and laid; and topped, cut, covered; and topped, burned, standing canes; it amounted to 34.9, 42.0 and 19.4 per cent respectively. The topped, standing canes showed the least loss, 12.4 per cent.

The losses due to the different treatments at the end of 13 days increased very greatly. The loss in topped, cut, and covered canes was the greatest, 43.8 per cent; and the topped, standing canes the least, 16.4 per cent.

It is rather striking to find throughout the experiments that the cut unburned canes, whether allowed to be exposed or covered with trash, always showed the greatest sugar loss. Canes treated thus also lost a great amount of sugar within even 4 days after the treatment. This loss might be due partly to the rapid loss of the moisture content of cut cane and partly to metabolic processes taking place in the cane, and to the germination of the eye buds of the terminal portion of the cane stalks, which would result in rapid sucrose inversion. That the germination of the eye buds was partly responsible for rapid sucrose inversion is shown also by the fact that throughout the work the sugar loss was greatest in the cut, covered canes. This result was probably because the buds germinated earlier and better owing to the cover of trash which increased the temperature in the cane and favored the development of the eye buds. The writer has observed that it is the practice of Filipino farmers after soaking the points or seed pieces to cover them to incubate them for some time before they are planted. These results contradict the findings of Lee, who, according to Henry (1929) found that for the duration of his experiment, the daily average loss was 6 per cent when the cane was left on the ground and only 3.6 per cent when the cane was put under light low shelter, made of bamboo and straw, in the field. He attributed the influences of the shelter to the low temperature rise in the canes, as he observed that there was a difference of temperature as great as 25°F. between the outside and the interior of the shelter from 9:00 a. m. to 2:00 p. m. Evidently, in the present study the mat of trash covering the cane increased the temperature rise in the cane instead of decreasing it and also increased the humidity because of diminished aëration; all conditions which favored the germination of the eye buds and the breaking up of sucrose into fermentable hexoses by bacterial and fungoid growths on the cane and enzymes in the juice. In the cut, burned canes, whether exposed or covered with trash, the sugar loss was much less than in the cut, unburned canes. This was probably due to the fact that little or no sucrose inversion resulting from the metabolic processes and especially from development of the eye buds took place in the burned canes because the cells of these canes were ruptured and broken down by the heat of the fire, hence water was more easily evaporated. Undoubtedly, the heat generated by the fire killed some and possibly all of the cells and the eye buds of the cane. It is also interesting to note from these results that after the cane was once cut and burned it made no appreciable difference in the losses of sugar whether the cane was allowed to be exposed or was covered with trash; in either case the losses in sugar were about the same.

The results also show that the deterioration of topped, burned, standing cane was less rapid than that which occurred in cut, unburned and cut, and unburned covered canes. These results agree with those obtained by Marcallino who, according to Alincastre (1926), found that the deterioration of burned cane which is left standing in the field is less rapid than in cut cane, even when no burning is done.

The topped, burned, standing cane lost more sugar than the topped, burned, cut, and topped, burned, cut and covered canes. Topping and cutting immediately after burning might have prevented rapid deterioration owing to enzymes being present in the tender part of the cane. These results agree with the report of Hind (1921) who stated that the deterioration of burned cane was less rapid when cane was cut than if it were left standing with the tops attached to the stalk. From the standpoint of the Central and grower, it would be an advantage to cut the burned canes as there would be less sugar loss than if they were allowed to stand in the field.

It will also be noted in table 2 that, in general, the deterioration of burned, topped, standing cane was more rapid than that of unburned, topped, standing cane. These results verified those obtained in the first experiment.

Experiment 3. Further studies on the effects of different treatments upon the yield of sugar cane. The results of this experiment are presented in table 3. This table shows the effects upon the yield of sugar cane of delayed harvesting of topped, standing and topped, cut canes.

Effects of the treatments upon the weight of the cane. It may be seen in table 3 that throughout the experiment the topped, cut canes lost more in weight than the topped, standing canes. In general, the loss in weight of the topped, cut canes increased as the time the canes were allowed to lie in the field was increased, with a minimum loss in weight of 14 per cent and a maximum loss of 26 per cent. On the other hand, the loss in weight of the topped, standing canes decreased as the time the canes were allowed to stand in the field was increased up to 12 and 15 days, when there was gain in weight of 3.33 and 1.34 per cent, respectively. These results may be explained as follows: In this third experiment, POJ 2878 variety was used. This variety is characterized by being an early and profusely flowering variety and producing at flowering one to four or more side shoots or "lalas" at the terminal or just below the terminal portion of the cane stalk. When the cane was topped and allowed to stand in the field the remaining small "lalas" might have developed and their young leaves continued to function normally, hence there would be an increase in the weight of the canes. Yap (1920) in his study on the photosynthesis of sugar cane found that young leaves were the most active, and the activity was found to decrease as the leaves became older. In cut canes, the leaves of the "lalas" dried up, hence there was probably rapid evaporation in the cane stalks.

Effects of the treatments upon the sugar content of the cane. It may be seen in table 3 that after 2 days the topped, standing and topped, cut canes each gave 1.5 per cent more sugar per ton cane than the control. After 4 days the topped, standing canes had 4.7 per cent and the cut canes had 1.5 per cent more sugar than the control.

At the end of 7 and 9 days the sugar loss of the topped, cut canes was 19.9 and 18.9 per cent, respectively. In the topped, standing canes after 7 and 9 days the loss of sugar was small, only 3.2 and 6.2 per cent, respectively. This small loss may be explained by the fact that although there was deterioration in topped, standing canes, photosynthetic activities of the young leaves of the "lalas" also continued.

In the topped, cut canes in 12 and 15 days the sugar loss was very great, being 22.3 and 41.0 per cent, respectively. On the other hand, in the topped, standing canes at the end of 12 days there was an increase of 3.1 per cent sugar and no loss nor gain at the end of 15 days. These results are quite the reverse of those obtained in the two preceding experiments, where it was found that the loss in sugar of the topped, standing canes increased as the time they were allowed to stand in the field was increased. The probable explanation for these contradicting results is: In the two preceding experiments, the varieties used, Luzon White, Pampanga Red, and N. G. 24-B are non-flowering varieties and do not produce "lalas". In this third experiment the variety used, POJ 2878 is an early and profusely flowering variety. It produces side shoots or "lalas" at the terminal or just below the terminal portion of the cane stalk at flowering. The leaves of the remaining "lalas" might have continued to function for photosynthetic activities and rapid accumulation of sucrose or sugar continued even after the cane was topped. These results seem to have some significant importance in that detasseling might be resorted to in flowering varieties of sugar cane in order to obtain more sugar.

SUMMARY AND CONCLUSIONS

In the present investigation, attempts were made to determine the effects of different treatments at harvesting upon the yield of sugar cane. The results reported in this paper were obtained under field conditions, in two harvesting seasons using flowering and non-flowering varieties of sugar cane. The conclusions drawn should be fairly reliable. The results of the experiments thus obtained may be summarized as follows:

1. The deterioration of cane after topping varied a great deal with the variety and possibly with the weather. In non-flowering varieties deterioration of the cane set in immediately after topping and losses of sucrose reached a high percentage when the cane was allowed to stand in the field for a long time. In N.G. 24-B, a non-flowering variety of sugar cane, a loss of 1.8 per cent sugar was obtained when the topped cane was allowed to stand in the field for one day and the loss amounted to 16.4 per cent at the end of 13 days.

In the flowering varieties, as POJ 2878, the loss in both weight of cane and sugar decreased as the time the topped cane was allowed to stand in the field was increased, up to 12 and 15 days when there was a gain in weight of cane of 3.33 and 1.34 per cent, respectively; and a gain in weight of sugar of 3.7 per cent at the end of 12 days and no loss nor gain at the end of 15 days.

2. Of all the treatments the topped, unburned, standing cane showed the least deterioration.

3. In the unburned, cut cane, whether left exposed or covered with trash, the sugar loss was the greatest. The deterioration of cut, unburned, covered cane was more rapid than in the cut, unburned, exposed cane.

4. Deterioration of cane was less rapid in burned, cut, exposed, and burned, cut, covered cane than in burned, standing cane.

5. After the cane was once cut and burned it made no appreciable difference in the losses of sugar whether the cane was left exposed or covered with trash; in both cases the losses in sugar were about the same.

The following recommendations may be made from these results:

1. The canes should be harvested immediately after topping.
2. If milling is to be delayed with unburned cane it is better to leave the topped cane standing in the field than to cut it.
3. If milling is to be delayed with burned cane, it is better to cut the cane than to let it stand in the field.
4. Covering of cut cane, whether burned or unburned in the field, with trash is a waste of labor and favors deterioration of unburned cane.
5. Detasseling of flowering varieties of sugar cane might increase the yield of sugar cane.

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TABLE 1

Showing the effects upon the yield of sugar cane of delayed harvesting of topped, standing and topped, burned, standing canes (mixed varieties, Luzon White and Pampanga Red)

TREATMENT	SAMPLE NO.	CRUSHER JUICE ANALYSES			PICULS SUGAR PER TON CANE	GAIN OR LOSS IN WEIGHT OF SUGAR	
		C. Brix	Polarization	Apparent purity			
			per cent			*P.S./T.C.*	*per cent*
Topped and allowed to stand in the field for five days.	1	21.09	18.86	89.4	2.263		
	2	21.29	18.81	88.4	2.242		
	3	20.80	18.69	89.9	2.251		
	4	20.09	17.80	88.6	2.124		
	5	20.99	18.76	89.4	2.251		
	Average	20.85	18.58	89.1	2.225	–0.042	– 1.8
Topped, burned, and allowed to stand in the field for five days.	1	18.99	14.46	76.1	1.549		
	2	19.10	14.56	76.2	1.562		
	3	19.50	14.51	74.4	1.526		
	4	18.59	14.13	76.0	1.512		
	5	18.29	14.53	75.3	1.544		
	Average	19.09	14.44	75.6	1.539	–0.728	–32.1
Control.	1	20.19	18.37	91.0	2.228		
	2	19.99	18.24	91.2	2.216		
	3	20.96	19.51	93.1	2.398		
	4	20.09	18.29	91.1	2.219		
	5	20.53	18.73	91.2	2.275		
	Average	20.35	18.63	91.5	2.267	—	—

TABLE 2

Showing the effects upon the yield of sugar cane of delayed harvesting of topped, standing; topped, cut; topped, cut, covered; topped, burned, standing; topped, burned, cut; topped, burned, cut, covered (variety N. G. 24-B)

TREATMENTS	DATE ANALYZED	TIME FROM TREATMENT TO ANALYSIS	CRUSHED JUICE ANALYSES			PICULS SUGAR PER TON CANE	GAIN OR LOSS IN WEIGHT OF SUGAR	
			C. Brix	Polarization	Apparent purity			
		days		*per cent*			*P.S./T.C.*	*per cent*
Topped, standing	3-11-32	1	21.43	19.33	90.2	2.332	—0.045	— 1.8
Topped, cut	3-11-32	1	22.70	19.92	87.8	2.364	—0.013	— 0.5
Topped, covered	3-11-32	1	23.40	20.69	88.4	2.466	+0.089	+ 3.7
Topped, burned, standing	3-11-32	1	22.31	20.12	90.2	2.428	+0.051	+ 2.1
Topped, burned, cut	3-11-32	1	22.40	19.58	87.4	2.325	—0.052	— 2.1
Topped, burned, cut, covered ..	3-11-32	1	22.50	19.54	86.8	2.302	—0.075	— 3.1
Control	3-11-32	—	23.22	20.16	86.9	2.377	—	—
Topped, standing	3-14-32	4	21.82	19.60	89.8	2.359	—0.060	— 2.4
Topped, cut	3-14-32	4	24.08	18.77	77.9	2.049	—0.370	—15.2
Topped, cut, covered	3-14-32	4	24.04	18.80	78.2	2.058	—0.361	—14.9
Topped, burned, standing	3-14-32	4	22.03	19.20	87.2	2.269	—0.150	— 6.2
Topped, burned, cut	3-14-32	4	23.51	20.08	85.4	2.341	—0.078	— 3.2
Topped, burned, cut, covered ..	3-14-32	4	24.08	20.53	85.3	2.391	—0.028	— 1.1
Control	3-14-32	—	23.00	20.31	88.3	2.419	—	—
Topped, standing	3-16-32	6	21.51	19.21	89.3	2.304	—0.038	— 1.6
Topped, cut	3-16-32	6	24.13	17.61	73.0	1.822	—0.520	—22.2
Topped, cut, covered	3-16-32	6	23.43	16.70	71.3	1.692	—0.650	—27.7
Topped, burned, standing	3-16-32	6	22.80	19.80	86.8	2.333	—0.009	— 0.3
Topped, burned, cut	3-16-32	6	24.92	20.80	83.5	2.388	+0.046	+ 1.9
Topped, burned, cut, covered ..	3-16-32	6	23.92	19.53	81.6	2.007	—0.135	— 5.7
Control	3-16-32	—	22.23	19.65	88.4	2.342	—	—
Topped, standing	3-18-32	8	22.42	19.94	88.9	2.385	—0.097	— 3.9
Topped, cut	3-18-32	8	24.61	17.41	70.3	1.950	—0.532	—21.4
Topped, cut, covered	3-18-32	8	24.91	17.27	69.3	1.703	—0.779	—31.3
Topped, burned, standing	3-18-32	8	21.31	18.02	81.6	2.087	—0.395	—15.9
Topped, burned, cut	3-18-32	8	26.70	21.59	80.9	2.424	—0.058	— 2.3
Topped, burned, cut, covered ..	3-18-32	8	24.78	20.12	81.2	2.265	—0.217	— 8.7
Control	3-18-32	—	23.51	20.81	88.5	2.482	—	—
Topped, standing	3-21-32	11	21.50	18.97	88.2	2.258	—0.322	—12.4
Topped, cut	3-21-32	11	24.91	17.13	68.8	1.678	—0.902	—34.9
Topped, cut, covered	3-21-32	11	24.61	16.09	65.4	1.495	—1.085	—42.0
Topped, burned, standing	3-21-32	11	21.56	18.06	83.8	2.079	—0.501	—19.4
Topped, burned, cut	3-21-32	11	25.17	20.13	80.0	2.242	—0.338	—13.1
Topped, burned, cut, covered ..	3-21-32	11	25.71	19.92	77.5	2.223	—0.357	—13.8
Control	3-21-32	—	23.78	21.41	90.0	2.580	—	—
Topped, standing	3-23-32	13	21.08	18.50	87.8	2.196	—0.432	—16.4
Topped, cut	3-23-32	13	25.45	17.27	67.9	1.669	—0.959	—36.4
Topped, cut, covered	3-23-32	13	25.41	16.27	64.0	1.476	—1.152	—43.8
Topped, burned, standing	3-23-32	13	21.40	15.59	72.9	1.671	—0.957	—36.4
Topped, burned, cut	3-23-32	13	26.01	19.40	74.6	2.045	—0.583	—22.1
Topped, burned, cut, covered ..	3-23-32	13	25.41	18.86	74.2	1.979	—0.649	—24.6
Control	3-23-32	—	23.68	21.62	91.3	2.628	—	—

TABLE 3

Showing the effects upon the yield of sugar cane of delayed harvesting of topped, standing and topped, cut canes (variety POJ 2878)

TREATMENTS	DATE WEIGHED AND ANALYZED	TIME FROM TREATMENT TO ANALYSIS	GAIN OR LOSS IN WT. OF CANES	CRUSHER JUICE ANALYSES			PICULS SUGAR PER TON CANE	GAIN OR LOSS IN WEIGHT OF SUGAR	
				C. Brix	Polarization	Apparent purity			
		days	*per cent*		*per cent*			*P.S./T.C.*	*per cent*
Topped, standing	3-21-34	1	— 9.40	21.04	19.60	93.15	2.396	+0.036	+ 1.5
Topped, cut	3-21-34	2	—17.45	23.15	20.16	87.08	2.396	+0.036	+ 1.5
Control	3-19-34	—	—	21.07	19.38	91.98	2.360	—	—
Topped, standing	3-23-34	4	—13.42	21.78	20.21	92.79	2.471	+0.111	+ 4.7
Topped, cut	3-23-34	4	—14.43	20.85	19.52	93.62	2.396	+0.036	+ 1.5
Control	3-23-34	—	—	21.07	19.38	91.98	2.360	—	—
Topped, standing	3-26-34	7	— 7.97	23.03	21.02	91.27	2.551	—0.085	— 3.2
Topped, cut	3-26-34	7	—20.25	23.20	18.80	81.03	2.109	—0.527	—19.9
Control	3-26-34	—	—	22.71	21.31	93.84	2.636	—	—
Topped, standing	3-28-34	9	— 1.33	21.31	19.97	93.71	2.471	—0.165	— 6.2
Topped, cut	3-28-34	9	—21.33	22.85	18.82	82.36	2.137	—0.499	—18.9
Control	3-28-34	-	-	22.76	21.33	93.72	2.636	-	
Topped, standing	3-31-34	12	+ 3.33	21.12	20.09	95.12	2.471	+0.075	+ 3.1
Topped, cut	3-31-34	12	—26.00	25.01	18.15	72.57	1.860	—0.536	—22.3
Control	3-31-34	—	—	21.47	19.68	91.66	2.396	—	—
Topped, standing	4- 3-34	15	+ 1.34	20.86	20.12	96.45	2.510	—	—
Topped, cut	4- 3-34	15	—20.40	23.50	15.60	66.38	1.478	—1.032	—41.1
Control	4- 3-34	—	—	21.56	20.31	94.20	2.510	—	—

ALCOHOL AND ALCOHOL-GASOLINE BLENDS AS FUELS FOR AUTOMOTIVE ENGINES: II. PERFORMANCE TESTS OF NEARLY STRAIGHT ALCOHOL OF DIFFERENT GRADES USING A FOUR-CYLINDER AND AN EIGHT-CYLINDER AUTOMOBILE ENGINE[1]

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Of the Department of Agricultural Engineering

WITH TWO TEXT FIGURES AND TWELVE CHARTS

GROUP II. WAUKESHA MOTOR

The objects of the experiments under this group were as follows:

1. To compare A-alcohol motor fuel No. 1, B-dehydrated alcohol, and gasoline as fuels when the engine was operated with and without pre-heating under variable speeds and loads at low and at high compression.

2. To determine the piston rings wear, carbon deposit, oil dilution and oil consumption after many hours of engine operation when two kinds of lubricating oil were used.

3. To compare the economy of the different fuels used.

Four series of tests, A, B, C, and D, were carried out. A general over-hauling of the engine was made before and after each series. The engine was over-hauled five times during the tests for ring wear, carbon deposit, oil dilution, and oil consumption.

Series A. Low compression head was used in this series. Three sets of jets having different sizes were fitted to the carburetor. One set was fixed in the laboratory to make the engine develop on alcohol a maximum power that could be delivered with sustained operation. Another set had openings suited for alcohol fuel. The jets were supplied by the International Harvester Company of Philippines. The third set of jets were adapted for running on gasoline.

For the tests with special jets, changes were made in the sizes of the compensating jet and of main jet. Two manifolds were needed, one to run the tests without pre-heating, and the other to run with continuous pre-heating. No device was used to control the degree of heating applied. The amount of heat energy supplied depended upon the nature of the exhaust gases which heated a large portion of the intake manifold.

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[1] Experiment Station contribution No. 1049. Received for publication April 12, 1935.

The four-cylinder engine used was a Waukesha motor typo XAH.
The eight-cylinder engine used was a Ford V-8.

The procedure followed in running the variable loads and speeds was the same as that described in Group I.[2] The speed interval was also 200 r. p. m.

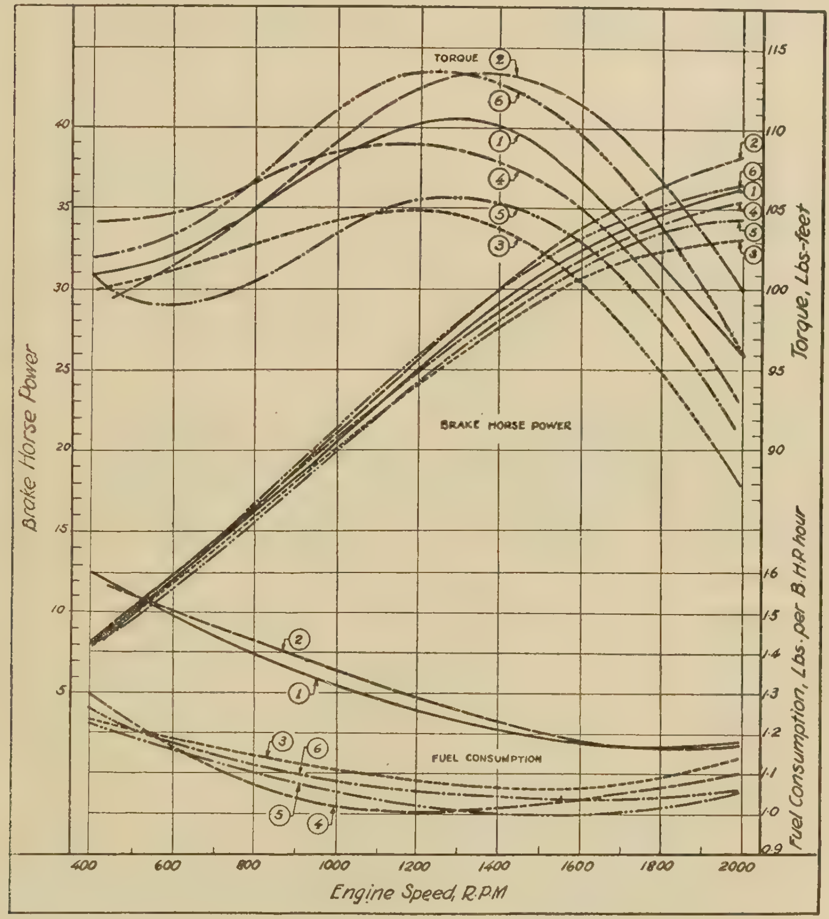

Chart 1.—Performance curves of Waukesha engine, Type XAH using low compression head. Full load.

Alcohol motor fuel No. 1.

1. Especial jets. With pre-heating.
2. Especial jets. No pre-heating.
3. International Harvester Company's jets. With pre-heating.
4. International Harvester Company's jets. No pre-heating.

B-dehydrated alcohol.

5. Especial jets. With pre-heating.
6. Special jets. No pre-heating.

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[2] *See* PHILIPPINE AGRICULTURIST, Vol. 24, No. 3.

Charts 1, 2, and 3 show:[3]

1. That higher power was developed with no pre-heating than with pre-heating.

2. That the peaks of the torque curves for all fuels appeared between 1200 r.p.m. and 1400 r.p.m.

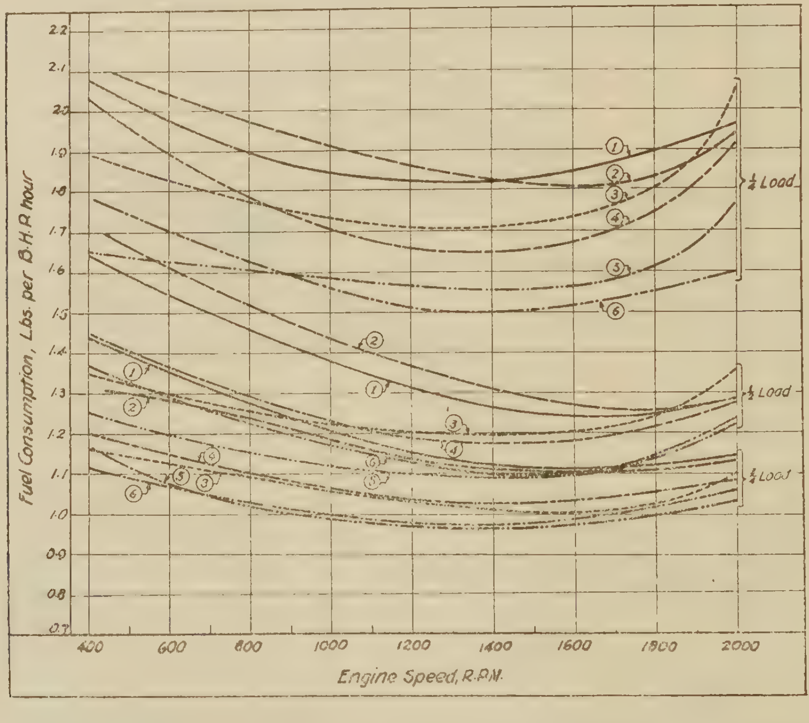

Chart 2.—Fuel economy curves at 3/4, 1/2, and 1/4 loads. Waukesha engine, Type XAH. Low compression.

Alcohol motor fuel No. 1.
1. Especial jets. With pre-heating.
2. Especial jets. No pre-heating.
3. International Harvester Company's jets. With pre-heating.
4. International Harvester Company's jets. No pre-heating.

B-dehydrated alcohol.
5. Especial jets. With pre-heating.
6. Especial jets. No pre-heating.

3. That beyond 1300 r.p.m. the operation of the engine at higher loads was steadier with A-alcohol motor fuel than with either B-dehydrated alcohol or gasoline. This steadiness was true especially

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[3] For purposes of economy, many tabulated results are not published in this paper. Original data are on file for reference in the Library of the College of Agriculture, University of the Philippines.

when the jets used were large enough to admit a slightly rich mixture.

4. That the maximum fuel economy was at about 1500 r.p.m. The most economical points were at about 1800 r.p.m., using a slightly rich mixture of A-alcohol motor fuels.

5. That by enlarging the fuel jets the fuel consumption could be increased much with very little increase in power developed with the use of alcohol fuels.

6. That the approximate ratio of fuel economy with gasoline as unity at 2000 r.p.m. and at 1500 r.p.m. varied from 1.276 to 1.737 (*see* table 1). The smallest ratio that could be obtained on short tests using a maximum power nearly the same as that obtainable with gasoline was about 1.33 for A-alcohol motor fuel and 1.21 for B-dehydrated alcohol. The operation of the engine at these settings on slow speeds was, however, not steady and the engine missed often. The load could not be maintained for a long period.

Series B. High compression head was used in series B. Two sets of tests B_1 and B_2 were carried out. In B_1, the effects of pre-heating were determined when the carburetor setting was adjusted to give the same power for both with and without pre-heating and also when not altered so as to develop different power without changing the size of jets. In B_2, the carburetor was regulated to give a maximum power that was nearly the same as the maximum that could be obtained using gasoline with low compression head for both with and without pre-heating. Only A-alcohol motor fuel No. 1 was used in this series. The spark was adjusted to give a maximum fuel economy for each load and speed.

The results of the tests are shown in charts 4, 5, and 6. The important points noted were as follows:

1. That although it was possible to start the engine on gasoline it would not carry on any load at high compression ratio.

2. That with fixed carburetor setting, greater power was developed without pre-heating than with pre-heating.

3. That the peak of the torque curves appeared at about 1400 r.p.m.

4. That the most economical point was at about 1700 r.p.m.

5. That without any pre-heating the engine missed occasionally at light loads and at low speeds. The distribution of the fuel did not seem to be very uniform under these conditions.

6. That the engine responded with quick acceleration to throttling effects at this compression ratio.

7. That the approximate power ratio and fuel economy ratio over that of gasoline at 2000 r.p.m. and at 1500 r.p.m. were: (*see* table 2).

Series C. Six tests were carried out in series C to determine the effects of pre-heating when the carburetor was adjusted to give the maximum power that the engine could develop with the use of special jets and of the manufacturer's jets. Tests were also made with a maximum power nearly the same as that obtainable using gasoline on low compression head. Only B-dehydrated alcohol was used. The results are given in charts 7, 8, and 9. These show:

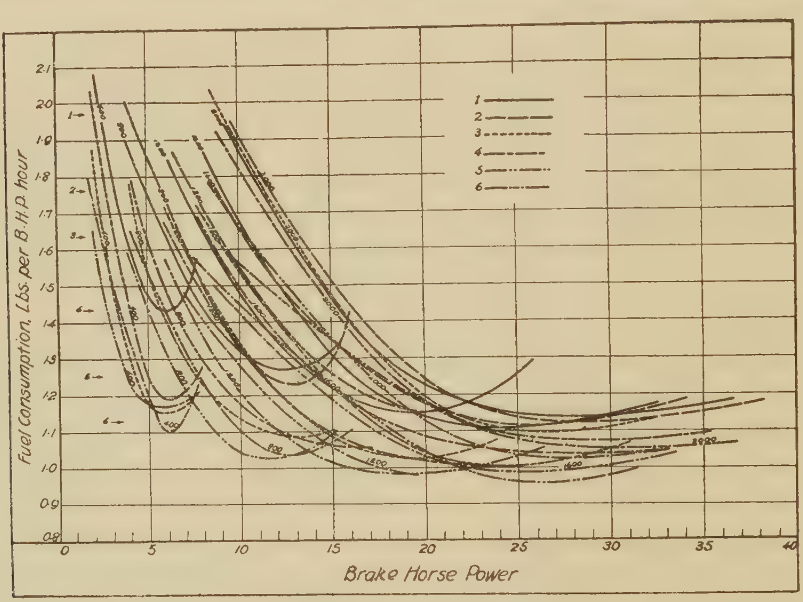

Chart 3.—Relation between fuel consumption and brake horsepower at different engine speeds. Waukesha engine, Type XAH. Low compression.

Alcohol motor fuel No. 1.
1. Especial jets. With pre-heating.
2. Especial jets. No pre-heating.
3. International Harvester Company's jets. With pre-heating.
4. International Harvester Company's jets. No pre-heating.

B-dehydrated alcohol.
5. Especial jets. With pre-heating.
6. Especial jets. No pre-heating.

1. That in general the engine developed higher maximum power

without pre-heating than with pre-heating. When the maximum power, however, was adjusted to be nearly the same as that obtainable

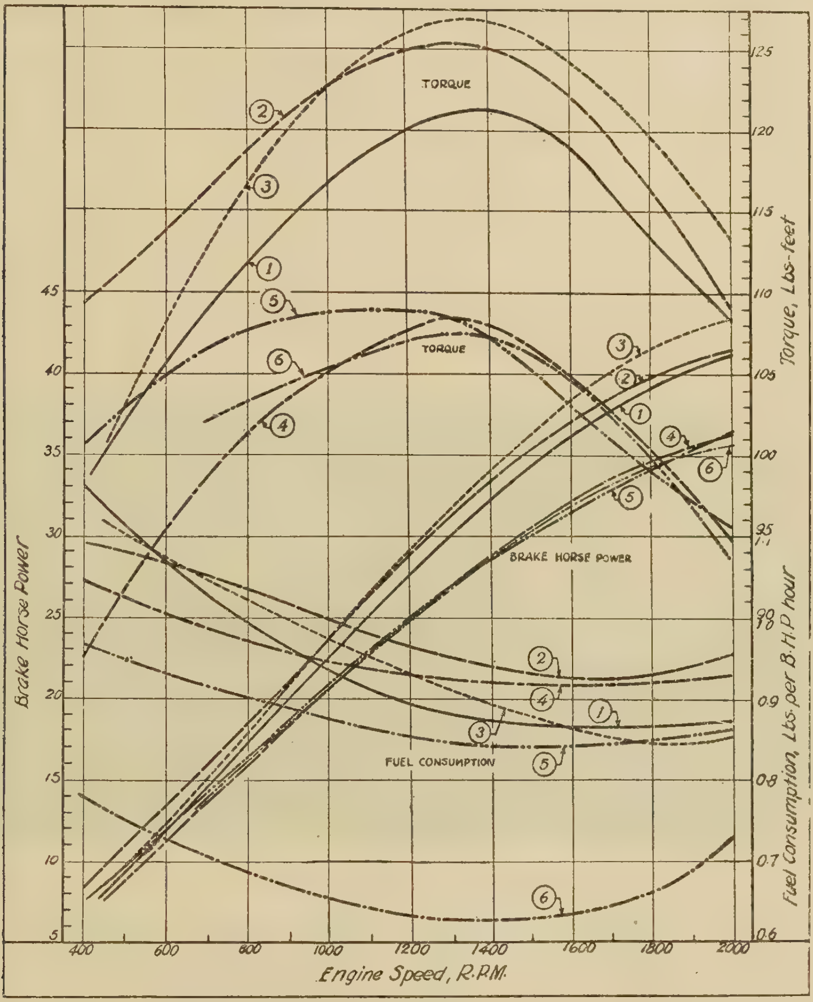

Chart 4.—Performance curves of Waukesha engine, Type XAH, using high compression head. International Harvester Company's jets used. Alcohol motor fuel No. 1. Full load.

1. With pre-heating. Normal load.
2. No pre-heating. Maximum load.
3. No pre-heating. Normal load.
4. With pre-heating. Load nearly the same as gasoline.
5. No pre-heating. Load nearly the same as gasoline.
6. No pre-heating. Gasoline.

using gasoline, slightly higher power was developed between 1100 r.p.m. and 1600 r.p.m. with pre-heating than without pre-heating.

2. That the peak of the torque curves was between 1200 r. p. m. and 1300 r.p.m.

3. That the most economical consumption was at about 1600 r.p.m.

4. That the approximate ratio of power developed and of fuel economy compared with gasoline at 2000 r.p.m. and at 1500 r.p.m. were variable. (*See* also table 3.)

Series D. Four series of tests were carried out in series D. Each series was divided into tests, each covering two days, tests arranged as follows: (*a*) one continuous 10-hour run at nearly 1500 r.p.m. on full throttle and maximum torque, and (*b*) an 8-hour continuous run with maximum torque at 2000, 1800, 1500, 1300, 1100, 900, 700, and 500 r.p.m. and with 3/4, 1/2, 1/4 the maximum torque at the same variable speeds. The duration of test at full throttle was 9 minutes each for 2000 and for 1800 r.p.m., 90 minutes for 1500 r.p.m., 15 minutes each for 1300, 1100, 700, and 500 r.p.m., and 30 minutes for 900 r.p.m. For the throttling tests at 3/4 maximum load, 9 minutes were spent for each test and for the 1/2 and 1/4 maximum load tests, 6 minutes were used for each.

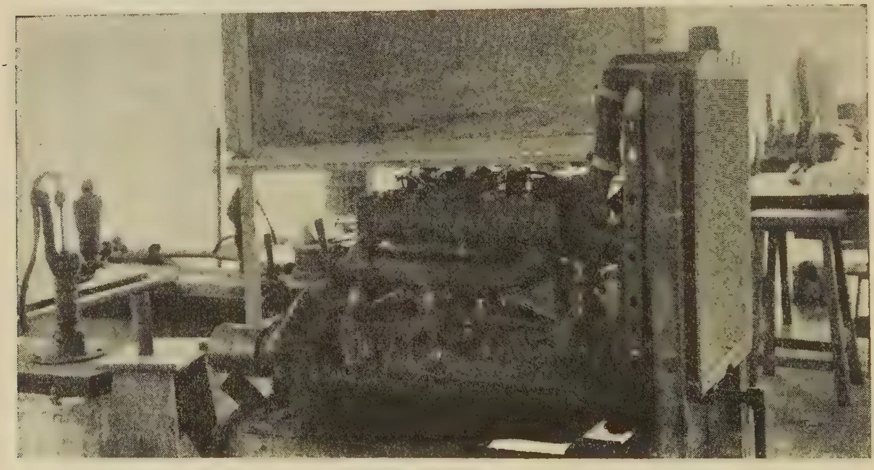

Fig. 1.—Showing the Waukesha engine Type XAH.

The fuels used were A-alcohol motor fuel No. 1, B-dehydrated alcohol, and gasoline. Two kinds of lubricating oil[4] for the crank case were used; namely, (1) X-AA and (2) Y-A. Every time X-AA was used, a top oil X-C was also mixed with the fuel in the proportion of about 1 part by volume for every 160 volumes. The test on gasoline did not include any X oils.

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[4] (X-AA)—stands for a certain company's crank case oil with grade AA. X-C stands for an upper cylinder lubricant.

(Y-A)—stands for another company's crank case oil with grade A.

The tests were conducted to measure the relative piston ring wear, carbon deposit, change in oil viscosity, and oil dilution.

The results of the tests were summarized as follows:

A-alcohol motor fuel No. 1
(With X-C and X-AA)

10 hours test

1. *Period of tests*
   a. Warming up = 15 minutes
   b. Load adjustment = 15 minutes
   c. Continuous tests = 600 minutes = 10 hours
   d. Idling after tests = 2 minutes

2. *Load and speed*
   a. Average dynamometer load = 55.0 pounds
   b. Average torque = 120.2 ft. lb.
   c. Average engine speed = 1508 r.p.m.
   d. Computed b.h.p. = 34.39
   e. Total b.h.p.-hr. = 343.9

3. *Fuel consumption*
   a. Total amount of fuel used = 338.74 pounds = 51.94 gallons = 196.62 liters
   b. Pounds fuel per b.h.p.-hr. = 0.9850
   c. B.h.p.-hr./gallon = 6.62
   d. B.h.p.-hr./liter = 1.749

4. *Oil consumption*
   a. Amount of fresh oil = 3780 cc. (X-AA)
   b. Amount of used oil = 3080 cc.
   c. Difference = 700 cc.
   d. Dilution after 10 hours = 0.6%
   e. Amount of oil consumed = 718.5 cc. = 0.1896 gallon
   f. Consumption per 100 b.h.p.-hr. = 208.9 cc. = 0.0552 gallon
   g. Temperature = 173°F.

5. a. Average water temperature = 155°F.
   b. Average room temperature = 98°F.
   c. Average relative humidity = 92%
   d. Barometer reading = 29.85″
   e. Turns of fuel needle valve = 2 1/2

6. *Remarks.* The dynamometer load during the first hour was 54 pounds. It decreased to 53.8 pounds in the second and third hours. During the remainder of the period the load was nearly steady at 55.1 pounds. The speed of the engine was almost constant.

8 hours test

1. Total b.h.p.-hr. = 134.42

2. *Oil consumption*
   - *a*. Amount of fresh oil used = 3780 cc. (X-AA)
   - *b*. Amount of used oil = 3580 cc.
   - *c*. Difference = 200 cc.

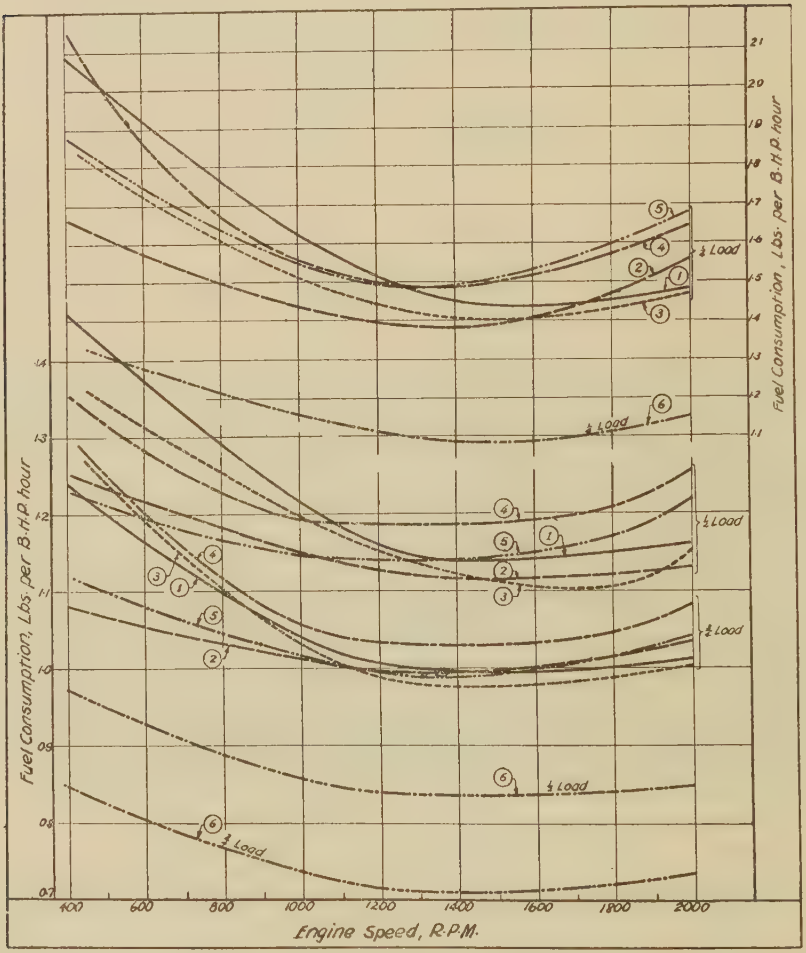

Chart 5.—Fuel economy curves at 3/4, 1/2, and 1/4 loads. Waukesha engine, Type XAH. High compression. International Harvester Company's jets used. Alcohol motor fuel No. 1.

1. With pre-heating. Normal load.
2. No pre-heating. Maximum load.
3. No pre-heating. Normal load.
4. With pre-heating. Load nearly the same as gasoline
5. No pre-heating. Load nearly the same as gasoline.
6. No pre-heating. Gasoline.

   - *d*. Dilution after 8 hours = 0.6%
   - *e*. Amount of oil consumed = 221.5 cc. = 0.0585 gallon
   - *f*. Consumption per 100 b.h.p.-hr. = 164.7 cc. = 0.0435 gallon

A-alcohol motor fuel No. 1
(With Y-A)

10 hours test

1. *Period of tests*
   - *a.* Warming up = 15 minutes
   - *b.* Load adjustment = 15 minutes
   - *c.* Continuous tests = 600 minutes = 10 hours
   - *d.* Idling after tests = 2 minutes
2. *Load and speed*
   - *a.* Average dynamometer load = 54.8 pounds
   - *b.* Average torque = 119.8 ft. lb.

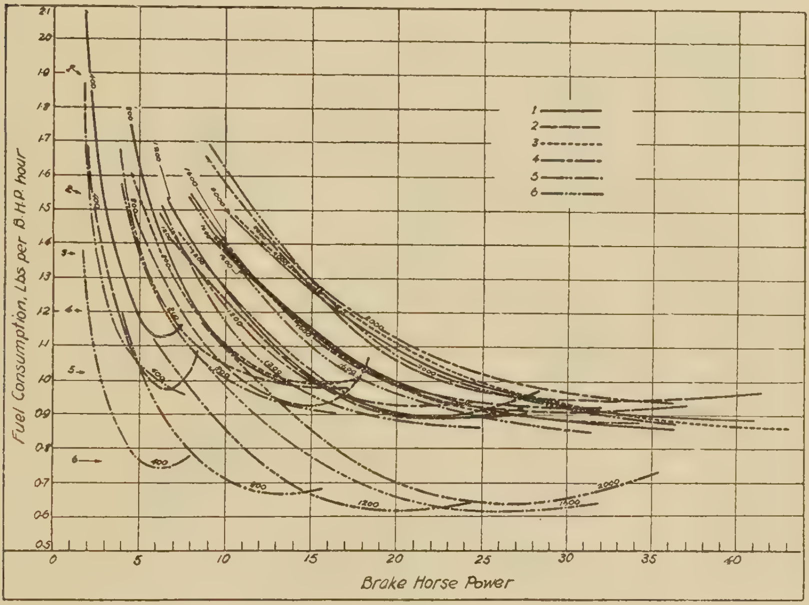

Chart 6.—Relation between fuel consumption and brake horsepower at different engine speeds. Waukesha engine, Type XAH. High compression. Alcohol motor fuel No. 1.

1. With pre-heating. Normal load.
2. No pre-heating. Maximum load.
3. No pre-heating. Normal load.
4. With pre-heating. Load nearly the same as gasoline.
5. No pre-heating. Load nearly the same as gasoline.
6. No pre-heating. Gasoline.

   - *c.* Average engine speed = 1502 r.p.m.
   - *d.* Computed b.h.p. = 34.24
   - *e.* Total b.h.p.-hr. = 342.4

3. *Fuel consumption*
   - *a.* Total amount of fuel used = 335.21 pounds = 51.4 gallons = 194.58 liters. Measured at room temperature.

  b. Pounds fuel per b.h.p.-hr. = 0.979
  c. B.h.p.-hr./gallon = 6.66
  d. B.h.p.-hr./liter = 1.760

4. *Oil consumption*
  a. Amount of fresh oil = 3780 cc. (Y-A)
  b. Amount of used oil = 2980 cc.
  c. Difference = 800 cc.
  d. Dilution after 10 hours = 0.9%
  e. Amount of oil used = 826.8 cc. = 0.2185 gallon
  f. Consumption per 100 b.h.p.-hr. = 241.4 cc. = 0.0637 gallon
  g. Temperature = 166°F.

5. *a*. Average water temperature = 150°F.
  b. Average room temperature = 84°F.
  c. Average relative humidity = 96%
  d. Barometer reading = 29.85"
  e. Turns of the fuel needle valve = 2 1/2

6. *Remarks.* The dynamometer load averaged 54.2 pounds in the first hour, 54.5 pounds in the second, third, and fourth hours; and 54.9 pounds in the remainder of the period. The engine speed was fairly constant at approximately 1500 r.p.m.

8 hours test

1. Total b.h.p.-hr. = 135.45

2. *Oil consumption*
  a. Amount of fresh oil used = 3780 cc. (Y-A)
  b. Amount of used oil = 3380 cc.
  c. Difference = 400 cc.
  d. Dilution after 8 hours = 1.0%
  e. Amount of oil consumed = 433.8 cc. = 0.1144 gallon
  f. Consumption per 100 b.h.p.-hr. = 320.2 cc. = 0.0845 gallon

B-dehydrated alcohol
(With X-C and X-AA)

10 hours test

1. *Period of tests*
  a. Warming up = 15 minutes
  b. Load adjustment = 15 minutes
  c. Continuous tests = 600 minutes = 10 hours
  d. Idling after tests = 2 minutes

2. *Load and speed*
  a. Average dynamometer load = 56.9 pounds
  b. Average torque = 124.2 ft. lb.
  c. Average engine speed = 1502 r.p.m.
  d. Computed b.h.p. = 35.7
  e. Total b.h.p.-hr. = 357

3. *Fuel consumption*
  a. Total amount of fuel used = 321.36 pounds = 50 gallons = 189.35 liters. Measured at room temperature.

b. Pounds fuel per b.h.p.-hr. = 0.900
c. B.h.p.-hr./gallon = 7.14
d. B.h.p.-hr./liter = 1.885

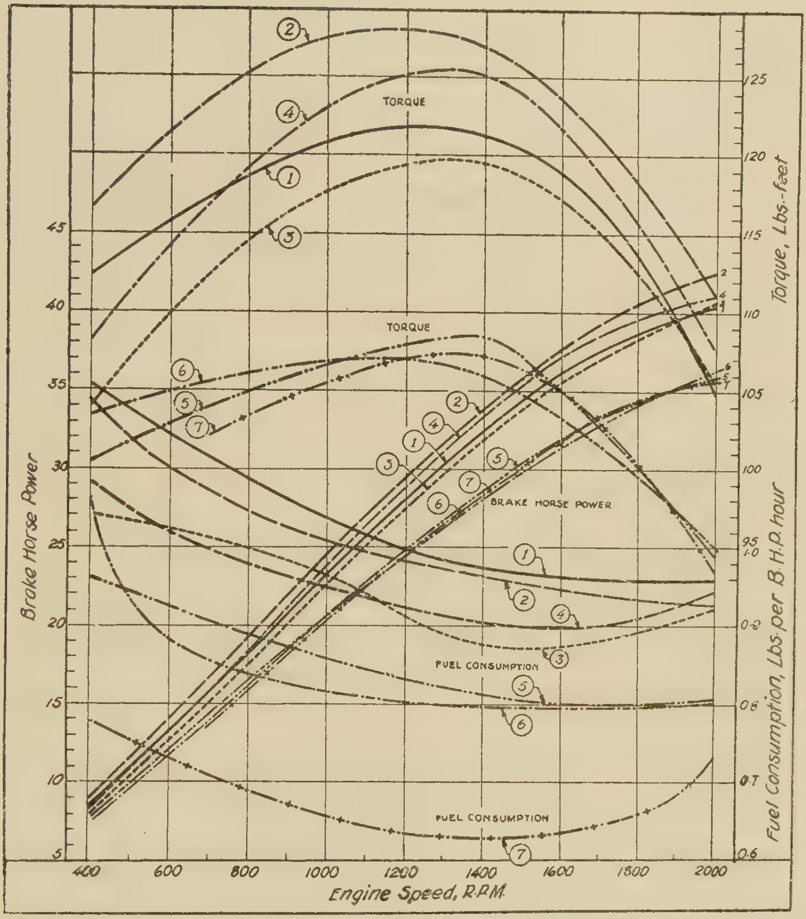

Chart 7.—Performance curves of Waukesha engine, Type XAH, using high compression head. B-dehydrated alcohol. Full load.

1. Especial jets used. Maximum power. With pre-heating.
2. Especial jets used. Maximum power. No pre-heating.
3. International Harvester Company's jets used. With pre-heating.
4. International Harvester Company's jets used. No pre-heating.
5. International Harvester Company's jets used. With pre-heating. Load nearly the same as gasoline.
6. International Harvester Company's jets used. No pre-heating. Load nearly the same as gasoline.
7. Regular jets for gasoline used. Low compression. Gasoline.

4. Oil consumption

a. Amount of fresh oil used = 3780 cc. (X-AA)
b. Amount of used oil = 3180 cc.

c. Difference = 600 cc.
d. Dilution after 10 hours = 0.8%
e. Amount of oil consumed = 625.4 cc. = 0.1653 gallon

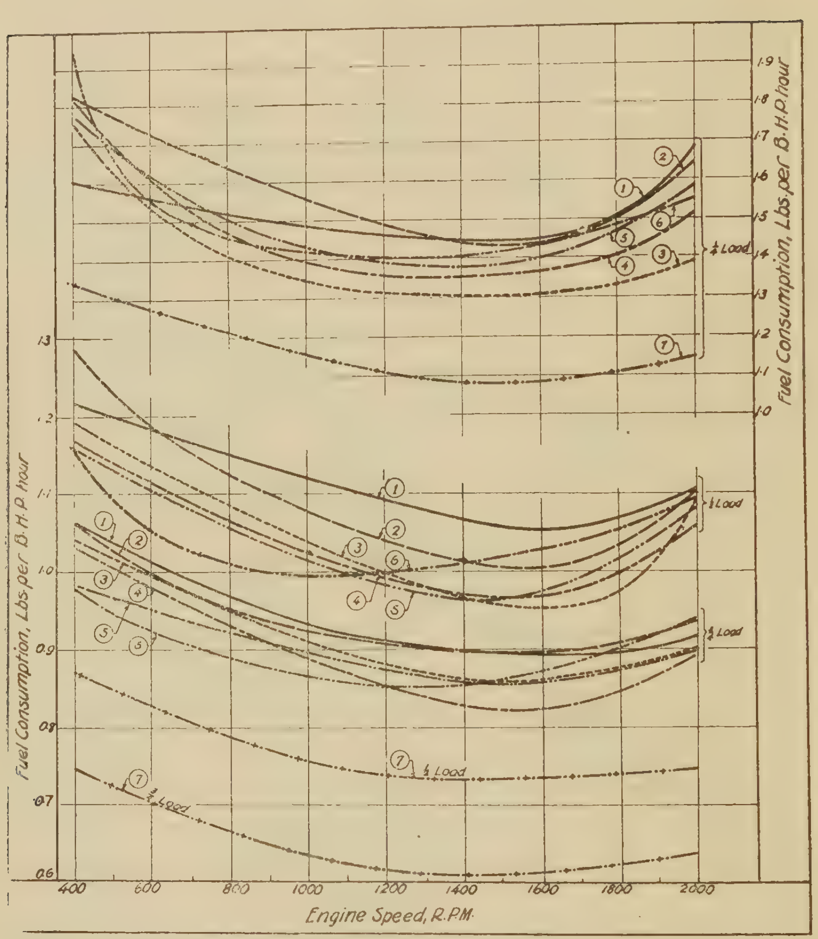

Chart 8.—Fuel economy curves at 3/4, 1/2, and 1/4 loads. Waukesha engine, Type XAH. High compression. B-dehydrated alcohol.

1. Especial jets used. Maximum power. With pre-heating.
2. Especial jets used. Maximum power. No pre-heating.
3. International Harvester Company's jets used. With pre-heating.
4. International Harvester Company's jets used. No pre-heating.
5. International Harvester Company's jets used. With pre-heating. Load nearly the same as gasoline.
6. International Harvester Company's jets used. No pre-heating. Load nearly the same as gasoline.
7. Regular jets for gasoline used. Low compression. Gasoline.

f. Consumption per 100 b.h.p.-hr. = 175.2 cc. = 0.0464 gallon
g. Temperature = 163°F.

5. *a*. Average water temperature = 154°F.
   b. Average room temperature = 85°F.
   c. Average relative humidity = 96%
   d. Barometer reading = 29.85″
   e. Turns of fuel needle valve = nearly 2 1/2

6. *Remarks.* The dynamometer load was 56.2 pounds in the first two hours. It remained nearly constant at 57.0 pounds during the remainder of the period. The speed did not vary much.

8 hours test

1. Total b.h.p.-hr. = 137.52
2. *Oil consumption*
   a. Amount of fresh oil used = 3780 cc. (X-AA)
   b. Amount of used oil = 3550 cc.
   c. Difference = 230 cc.
   d. Dilution after 8 hours = 0.9%
   e. Amount of oil consumed = 262 cc. = 0.0693 gallon
   f. Consumption per 100 b.p.h.-hr. = 190.5 cc. = 0.0504 gallon

B-dehydrated alcohol
(With Y-A)

10 hours test

1. *Period of tests*
   a. Warming up = 15 minutes
   b. Load adjustment = 15 minutes
   c. Continuous tests = 600 minutes = 10 hours
   d. Idling after tests = 2 minutes
2. *Load and speed*
   a. Average dynamometer load = 55.5 pounds
   b. Average torque = 121.2 ft. lb.
   c. Average engine speed = 1498 r.p.m.
   d. Computed b.h.p. = 34.61
   e. Total b.h.p.-hr. = 346.1
3. *Fuel consumption*
   a. Total amount of fuel used = 293.26 pounds = 44.6 gallons = 168.80 liters
   b. Pounds fuel per b.h.p.-hr. = 0.847
   c. B.h.p.-hr./gallon = 7.76
   d. B.h.p.-hr./liter = 2.051
4. *Oil consumption*
   a. Amount of fresh oil used = 3780 cc. (Y-A)
   b. Amount of used oil = 3100 cc.
   c. Difference = 680 cc.
   d. Dilution after 10 hours = 0.4%
   e. Amount of oil consumed = 692.4 cc. = 0.1831 gallon
   f. Consumption per 100 b.h.p.-hr. = 200 cc. = 0.0529 gallon
   g. Temperature = 164°F.

5. *a*. Average water temperature = 153°F.
    b. Average room temperature = 88°F.
    c. Average relative humidity = 99%
    d. Barometer reading = 29.78″
    e. Turns of fuel needle valve = nearly 2 1/2
6. *Remarks*. The load was about 55.2 pounds in the first hour, 55.4 pounds in the second and third hours, and 55.6 pounds in the remaining period. The speed was fairly constant.

8 hours test

1. Total b.h.p.-hr. = 135.14
2. *Oil consumption*
    a. Amount of fresh oil used = 3780 cc. (Y-A)
    b. Amount of used oil = 3430 cc.
    c. Difference = 350 cc.
    d. Dilution after 8 hours = 0.6%
    e. Amount of oil consumed = 370.6 cc. = 0.979 gallon
    f. Oil consumption per 100 b.h.p.-hr. = 274.2 cc. = 0.0725 gallon

Gasoline
(With Y-A)

10 hours test

1. *Period of tests*
    a. Warming up = 15 minutes
    b. Load adjustment = 15 minutes
    c. Continuous tests = 600 minutes = 10 hours
    d. Idling after tests = 2 minutes
2. *Load and speed*
    a. Average dynamometer load = 48.7 pounds
    b. Average torque = 106.5 ft. lb.
    c. Average engine speed = 1501 r.p.m.
    d. Computed b.h.p. = 30.44
    e. Total b.h.p.-hr. = 304.4
3. *Fuel consumption*
    a. Total amount of fuel used = 195.50 pounds = 32.3 gallons = 122.36 liters
    b. Pounds fuel per b.h.p.-hr. = 0.643
    c. B.h.p.-hr./gallon = 9.43
    d. B.h.p.-hr./liter = 2.488
4. *Oil consumption*
    a. Amount of fresh oil used = 3780 cc. (Y-A)
    b. Amount of used oil = 3280 cc.
    c. Difference = 500 cc.
    d. Dilution after 10 hours = 4.40%
    e. Amount of oil consumed = 644 cc. = 0.1702 gallon
    f. Consumption per 100 b.h.p.-hr. = 211 cc. = 0.0559 gallon

5. *a*. Average water temperature = 150°F.
   b. Average room temperature = 86°F.
   c. Average relative humidity = 88%
   d. Barometer reading = 28.87″
   e. Turns of the needle valve = nearly 1 1/2

6. *Remarks.* The dynamometer load was about 48.1 pounds in the first three hours and remained at nearly 49.0 pounds in the remaining period. The speed was fairly constant at 1500 r.p.m.

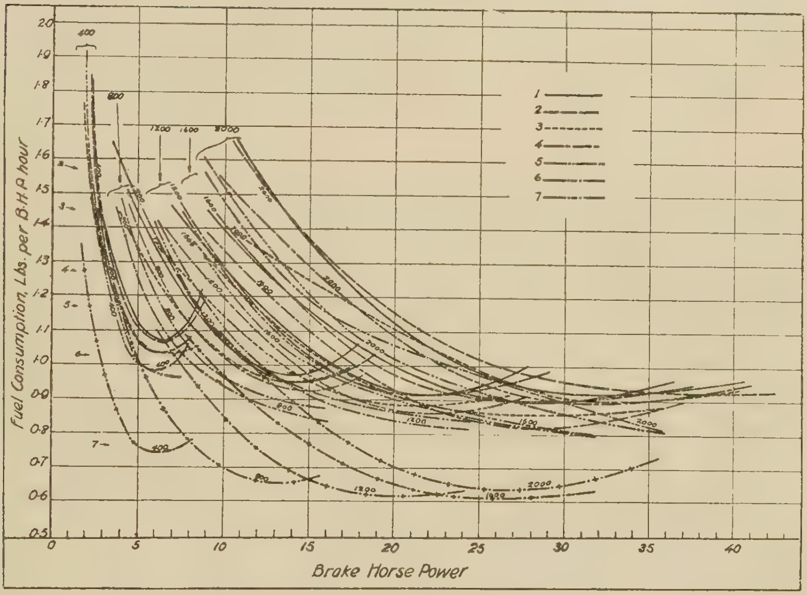

Chart 9.—Relation between fuel consumption and brake horsepower at different engine speeds. Waukesha engine, Type XAH. High compression. B-dehydrated alcohol.

1. Especial jets used. Maximum power. With pre-heating.
2. Especial jets used. Maximum power. No pre-heating.
3. International Harvester Company's jets used. With pre-heating.
4. International Harvester Company's jets used. No pre-heating.
5. International Harvester Company's jets used. With pre-heating. Load nearly the same as gasoline.
6. International Harvester Company's jets used. No pre-heating. Load nearly the same as gasoline.
7. Regular jets for gasoline used. Low compression. Gasoline.

8 hours test

1. Total b.h.p.-hr. = 117.42
2. *Oil consumption*
   a. Amount of fresh oil used = 3780 cc. (Y-A)
   b. Amount of used oil = 3600 cc.
   c. Difference = 180 cc.

d. Amount of dilution after 8 hours = 4.88%
e. Amount of oil consumed = 355.68 cc. = 0.0941 gallon
f. Consumption per 100 b.h.p.-hr. = 302.9 cc. = 0.0801 gallon

Ring wear. The tests on ring wear indicated: (*see* table 4).

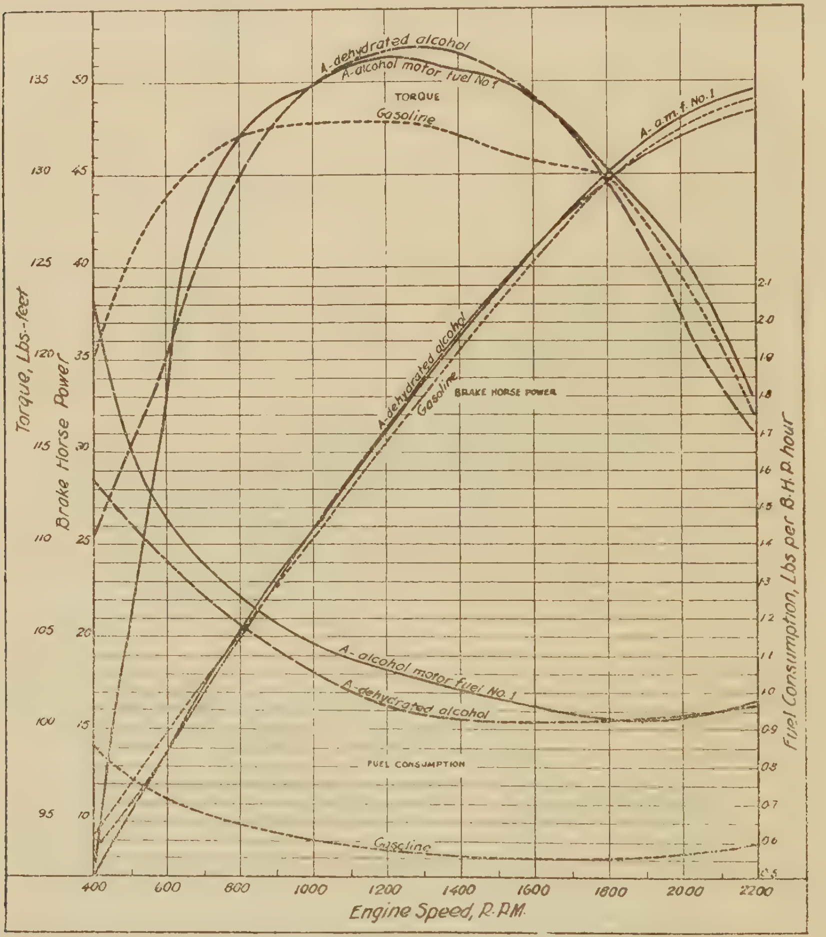

Chart 10.—Performance curves of Ford V-8 engine using gasoline, A-dehydrated alcohol, and alcohol motor fuel No. 1 as fuels. Full load.

1. That the total ring wear in alcohol fuels with the use of Y-A crank case oil without any upper cylinder lubricant was more than three times as much as that with X-AA crank case oil and X-C upper cylinder lubricant.

2. That with the use of Y-A crank case oil on alcohol fuels the scrape ring had the greatest total ring wear. Using X-C upper cylinder lubricant and X-AA crank case oil, compression ring No. 1 averaged the greatest total wear. The test on gasoline using Y-A oil without upper cylinder lubricant showed that the most wear was also in compression ring No. 1.

3. That the total ring wear on the tests with gasoline was less than that obtained on alcohol tests with Y-A crank case oil but was greater than that with X-AA crank case oil and X-C upper cylinder lubricant.

Carbon deposit. The tests in carbon deposit indicated: (*see* table 5)

1. That approximately 12 per cent more carbon was collected on the test with A-alcohol motor fuel No. 1, when Y-A crank case oil was used than when X-AA crank case oil and X-C upper lubricant were used. The increase was about 10 per cent in a similar test on B-dehydrated alcohol.

2. That the largest deposits in all tests were collected on the piston heads and cylinder heads.

3. That the ring grooves for the tests using upper cylinder lubricants showed more carbon deposit to a marked degree than those without upper cylinder lubricant.

4. That the total carbon deposit in using gasoline was about 17 per cent greater than the result of the test on A-alcohol motor fuel No. 1 and about 14 per cent greater than in the test with B-dehydrated alcohol.

Viscosities of oil used. The following results were observed on the change of viscosities of the different crank case oil used. (*see* table 6).

1. That in all tests with alcohol fuels there was a marked increase in viscosity as the length of time of test was increased.

2. That the test on gasoline showed a decrease in viscosity especially in the short run with variable speeds and loads.

GROUP III. FORD V-8

The objects of the tests under this group were as follows:

1. To compare A-alcohol motor fuel No. 1, B-dehydrated alcohol, and gasoline as fuels when the engine was run under different speeds and loads. The following were determined for each fuel.

a. Maximum brake horsepower and fuel economy at 2200 r.p.m. and at a speed interval of approximately 200 r.p.m. This formed the full throttle tests.

b. Fuel economy at 3/4, at 1/2, and at 1/4 maximum brake horsepower at each of the speeds. Proper throttle setting was made for each load.

2. To observe the general behavior of the engine when run with the different fuels used.

The engine had never been run in any place before because it was assembled in Manila from spare parts only. Approximately 50 hours were spent breaking-in the motor in the testing laboratory of the College. The accessories included in the tests were muffler and fan. A special water cooling device was made so that the temperature of the circulating water could be controlled. Air cleaner was not used.

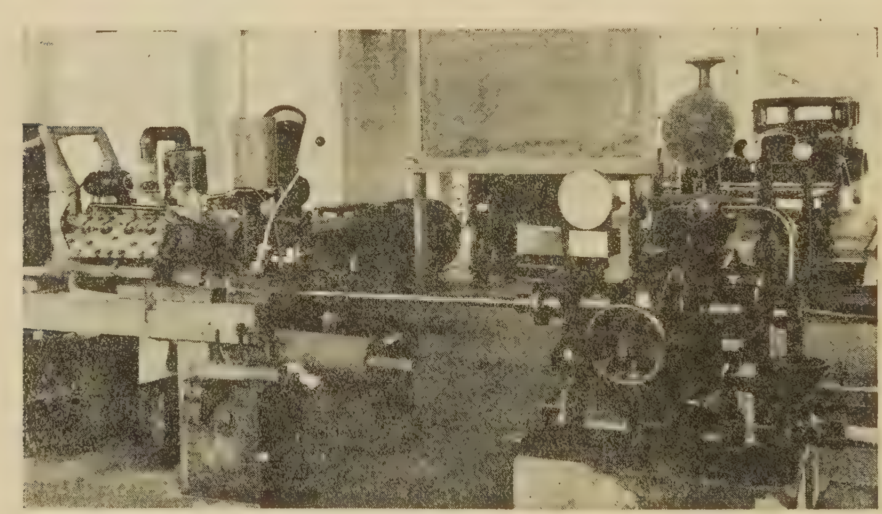

Fig. 2.—Showing a Ford V-8 being tested on the block.

The spark was adjusted to give the best horsepower output for each fuel. The fuel passages in the carburetor were altered when alcohol fuels were used so as to admit enough liquid to produce the brake horsepower desired. The following changes were made in the carburetor:

1. The inside diameter of the aspirating tube (Code 18 No. 18-9522) was enlarged from its original size of 0.1200″–0.1285″ (Drill No. 30-31) to 0.1470″ (Drill No. 26).

2. The contracted end of the carburetor aspirating jet (Code 18 No. 18-9540) was enlarged from its original size of 0.0730″ diameter (Drill size No. 49) to 0.0820″ diameter (Drill size No. 45).

3. One end of the metering pin was enlarged and tapered off to a point.

Short trial tests for power and for fuel economy were also made with the spark plug gap at 0.035 and the interrupter gap at 0.018. Test runs were not made until the engine had been run-in for at least 30 minutes and the brake load and speed had remained constant and steady. The tests were carried out using as speed limits only the highest and the lowest steady operating r.p.m. of the engine.

The results of the tests are plotted in charts 10, 11, and 12. The points indicated as observed were:

1. That the maximum torque between the speeds of about 800 r.p.m. and 1800 r.p.m. was higher in alcohol fuels than in gasoline by about 2 lb.-ft. Beyond 1800 r.p.m. the torque of A-alcohol motor fuel No. 1 was highest and that of B-dehydrated alcohol, lowest. Below 800 r.p.m., the torque of gasoline did not drop as rapidly as those of the alcohol fuels. From 400 r.p.m. to 1800 r.p.m., there was very little difference between the torques of the B-dehydrated alcohol and of the A-alcohol motor fuel No. 1. The power obtained with the B-dehydrated alcohol markedly dropped beyond this point.

2. That the operation of the engine using the fuels given above was smooth at all speeds, idling was excellent, and only very occasional missings were heard at 400 r.p.m. with maximum load. The brake loads, the speed, the rate of fuel consumption, and the operating temperature remained substantially constant and steady throughout each test. Starting from cold was as easy with alcohol fuels as it was with gasoline. Runs of longer duration from 1800 r.p.m. and upwards with full throttle on gasoline showed indications of detonation and decrease of power. This characteristic was not observed in alcohol fuels. All the conditions of satisfactory operation in alcohol fuels were reached only after the carburetor was altered and the spark advanced to suit the motor alcohol used.

3. That the engine was very economical on gasoline when the metering pin was adjusted to give the recorded power at 2200 r.p.m. on full throttle. Attempts to develop higher power than the maximum obtained with such arrangements resulted in a larger fuel consumption at all speeds and in a somewhat unsteady operation at low speeds. The engine also missed occasionally and the exhaust gases

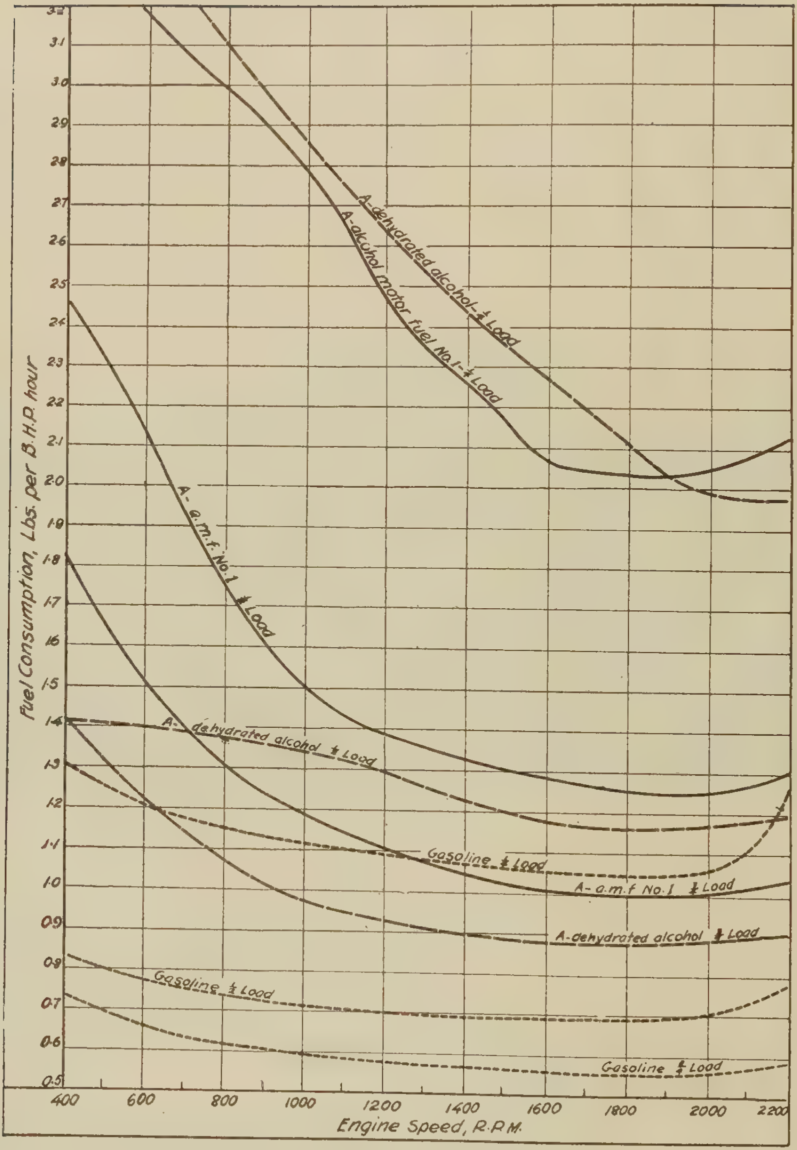

Chart 11.—Fuel economy curves of Ford V-8 engine using gasoline, A-dehydrated alcohol, and alcohol motor fuel No. 1 as fuels. Loads, 3/4, 1/2, and 1/4 of full load.

showed signs of richness. The most economical consumption for all fuels at full throttle appeared at about 1800 r.p.m. The minimum values at fractional loads as taken from the curves were as follows:

Fuel	*Full load*	*3/4 load*	*1/2 load*	*1/4 load*
	Pounds of fuel per brake horsepower hour			
A-alcohol motor fuel No. 1	0.923	0.995	1.245	2.032
B-dehydrated alcohol	0.920	0.875	1.160	1.925
Gasoline	0.555	0.552	0.689	1.040

Many short tests on alcohol fuels were made to show that by altering the carburetor adjustments it was possible to produce a maximum power at high speeds that was much greater than could be obtained using gasoline at the same speed without the engine showing signs of laboring or of decrease of power. An increase of over 10 per cent in power was exhibited in a test of over 10 minutes duration by the A-alcohol motor fuel No. 1 with perfect operation at about 2250 r.p.m. The running of the engine, when the r.p.m. was

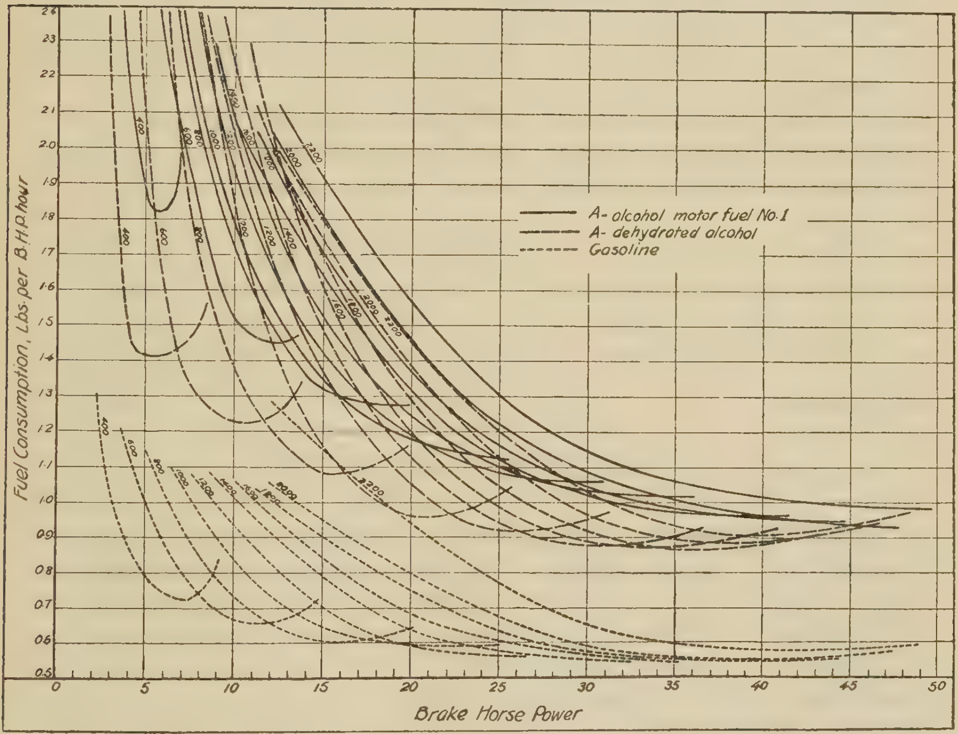

Chart 12.—Relation between fuel consumption and brake horsepower at different engine speeds. Ford V-8. Fuels, gasoline, A-dehydrated alcohol, and alcohol motor fuel No. 1.

reduced below 800 was not as steady, however, as at high speed. The fuel consumption with this setting was also high. Another test was made with alcohol to produce a fuel economy of about 8 per cent lower than what was obtained, as shown in the curves in chart 20. This was accomplished by making the mixture leaner. The engine, however, performed uniformly and steadily at part loads only and developed a maximum power about 2 per cent less than the maximum on gasoline at 2200 r.p.m. The writer believes that this setting would be satisfactory to most users of automobile engines because they do not often operate them at full load. If pressed for very high pulling capacity with this setting it will be necessary to change gears.

4. That by keeping the alcohol mixture a little rich, it was possible to give the engine a pick up with alcohol fuels equally as good as with gasoline.

5. That the approximate consumption ratio of the three fuels at fractional loads, by volume and by weight based on minimum values taken from the curves, were as follows: (*see* also table 7).

	Full load	*3/4 load*	*1/2 load*	*1/4 load*
Fuel	*Pounds of fuel per brake horsepower hour*			
A-alcohol motor fuel No. 1 ..	1.663	1.802	1.807	1.956
	1.512	1.645	1.651	1.785
B-dehydrated alcohol	1.656	1.585	1.684	1.851
	1.531	1.466	1.557	1.711
Gasoline	1.000	1.000	1.000	1.000
	1.000	1.000	1.000	1.000

Upper figures refer to ratio by weight.
Lower ” ” ” ” ” volume.

The ratios between alcohol fuels and gasoline given above were high for two reasons; namely, (1) The gasoline consumption was extraordinarily low, being about 10 per cent lower than the average for most automobile engines, and (2) the alcohol fuel consumption was based upon tests when the carburetor was set to deliver a higher maximum power than gasoline at 2200 r.p.m. Short tests showed that the ratio by volume was lowered to about 1.42 in A-alcohol motor fuel No. 1 and to about 1.36 in B-dehydrated alcohol when the maximum power was made about 2 per cent lower than the maximum for gasoline.

TABLE 1

Power and fuel economy at fractional loads using A-alcohol motor fuel No. 1, B-dehydrated alcohol, and gasoline at 2000 r.p.m. and 1600 r.p.m. Low compression head used

FUEL			LOAD	BRAKE HORSEPOWER		RATE OF FUEL CONSUMPTION IN LB./B.H.P.-HR.		MAXIMUM POWER DEVELOPED IN TERMS OF GASOLINE		FUEL CONSUMPTION IN TERMS OF GASOLINE	
				At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.
Gasoline			Full load	35.62	30.40	0.730	0.630	100.00	100.00	1.000	1.000
			3/4 "	26.84	22.70	0.633	0.616			1.000	1.000
			1/2 "	17.90	15.12	0.749	0.740			1.000	1.000
			1/4 "	9.00	7.53	1.145	1.087			1.000	1.000
A-alcohol motor fuel No. 1	Special jets used.	With preheating	Full load	36.60	30.90	1.180	1.183	102.75	101.64	1.476	1.715
			3/4 "	27.41	23.41	1.139	1.107			1.643	1.642
			1/2 "	18.25	15.50	1.282	1.245			1.564	1.536
			1/4 "	9.16	7.75	1.965	1.830			1.566	1.537
		No preheating	Full load	38.35	32.15	1.175	1.198	107.66	105.75	1.470	1.737
			3/4 "	28.78	24.12	1.126	1.109			1.624	1.645
			1/2 "	19.19	16.00	1.281	1.279			1.563	1.579
			1/4 "	9.58	8.00	1.941	1.810			1.548	1.521
	Company's jet used.	With preheating	Full load	33.35	29.51	1.140	1.060	93.62	97.07	1.426	1.537
			3/4 "	25.00	22.36	1.094	0.995			1.578	1.475
			1/2 "	16.67	14.75	1.355	1.192			1.653	1.471
			1/4 "	8.38	7.38	2.044	1.715			1.630	1.441
		No preheating	Full load	35.40	30.75	1.090	1.022	99.38	101.15	1.364	1.482
			3/4 "	26.57	23.07	1.076	1.025			1.552	1.520
			1/2 "	17.67	15.37	1.272	1.180			1.551	1.456
			1/4 "	8.38	7.69	1.915	1.650			1.527	1.386
B-dehydrated alcohol	Company's jet used.	With preheating	Full load	34.57	29.90	1.052	1.021	97.05	98.35	1.334	1.499
			3/4 "	25.84	22.42	1.029	0.961			1.504	1.443
			1/2 "	17.25	14.95	1.232	1.086			1.523	1.358
			1/4 "	8.58	7.48	1.766	1.540			1.427	1.310
		No preheating	Full load	36.75	31.89	1.061	0.998	103.17	104.90	1.345	1.464
			3/4 "	27.75	23.91	1.052	0.972			1.538	1.459
			1/2 "	18.37	15.94	1.224	1.095			1.513	1.369
			1/4 "	9.18	7.97	1.593	1.500			1.286	1.276

TABLE 2

Power and fuel economy at fractional loads using A-alcohol motor fuel No. 1 at 2000 r.p.m. and 1500 r.p.m. High compression head used

FUEL			LOAD	BRAKE HORSEPOWER		RATE OF FUEL CONSUMPTION IN LB./B.H.P.-HR.		MAXIMUM POWER DEVELOPED IN TERMS OF GASOLINE		FUEL CONSUMPTION IN TERMS OF GASOLINE	
				At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.
A-alcohol motor fuel No. 1	Load higher than that of gasoline	With pre-heating	Full load	41.25	34.50	0.872	0.866	115.80	113.48	1.091	1.255
			3/4 "	30.94	25.87	0.912	0.895			1.316	1.327
			1/2 "	20.60	17.25	1.062	1.040			1.295	1.284
			1/4 "	10.32	8.62	1.480	1.440			1.149	1.494
		No pre-heating	Full load	41.50	35.37	0.955	0.930	116.50	116.34	1.195	1.348
			3/4 "	31.18	26.52	0.936	0.899			1.350	1.334
			1/2 "	20.74	17.68	1.032	1.018			1.259	1.257
			1/4 "	10.33	8.84	1.556	1.385			1.105	1.437
			Full load	43.20	36.25	0.851	0.877	121.28	119.24	1.065	1.271
			3/4 "	32.35	27.18	0.900	0.877			1.298	1.300
			1/2 "	21.60	18.12	1.060	1.012			1.234	1.250
			1/4 "	10.82	9.06	1.468	1.398			1.115	1.450
	Load nearly the same as gasoline	With pre-heating	Full load	36.27	30.25	0.929	0.917	101.82	99.50	1.162	1.329
			3/4 "	27.17	22.68	0.988	0.930			1.425	1.379
			1/2 "	18.20	15.12	1.165	1.087			1.325	1.343
			1/4 "	9.07	7.56	1.637	1.495			1.192	1.550
		No pre-heating	Full load	36.68	30.31	0.862	0.840	102.97	99.70	1.078	1.217
			3/4 "	27.50	22.74	0.940	0.897			1.356	1.330
			1/2 "	18.34	15.15	1.121	1.045			1.367	1.290
			1/4 "	9.17	7.58	1.676	1.506			1.201	1.563

TABLE 3

Power and fuel economy at fractional loads using B-dehydrated alcohol at 2000 r.p.m. and 1500 r.p.m. High compression head used

FUEL			LOAD	BRAKE HORSEPOWER		RATE OF FUEL CONSUMPTION IN LB./B.H.P.-HR.		MAXIMUM POWER DEVELOPED IN TERMS OF GASOLINE		FUEL CONSUMPTION IN TERMS OF GASOLINE	
				At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.	At 2000 r.p.m.	At 1500 r.p.m.
B-dehydrated alcohol		With pre-heating (special jets)	Full load	43.40	35.20	0.890	0.898	121.84	115.79	1.196	1.319
			3/4 "	32.50	26.70	0.831	0.842			1.215	1.264
			1/2 "	21.68	17.81	0.960	0.954			1.186	1.192
			1/4 "	10.82	8.89	1.362	1.350			1.100	1.149
	Load higher than that of gasoline	With pre-heating	Full load	40.15	33.75	0.924	0.871	112.71	111.01	1.243	1.279
			3/4 "	30.17	25.32	0.902	0.855			1.318	1.284
			1/2 "	20.40	16.88	1.099	0.957			1.358	1.196
			1/4 "	10.00	8.44	1.398	1.310			1.129	1.114
		No pre-heating	Full load	41.00	35.37	0.947	0.900	115.10	116.34	1.274	1.321
			3/4 "	30.76	26.52	0.891	0.822			1.302	1.235
			1/2 "	20.50	17.68	1.062	0.968			1.312	1.210
			1/4 "	10.25	8.84	1.521	1.360			1.229	1.157
	Load nearly the same as that of gasoline	With pre-heating	Full load	35.81	30.25	0.805	0.804	100.53	99.50	1.082	1.180
			3/4 "	26.92	22.68	0.897	0.855			1.311	1.284
			1/2 "	17.92	15.12	1.081	0.966			1.335	1.206
			1/4 "	8.91	7.56	1.594	1.386			1.287	1.180
		No pre-heating	Full load	36.25	30.30	0.801	0.795	101.77	99.67	1.077	1.167
			3/4 "	27.08	23.72	0.939	0.861			1.373	1.293
			1/2 "	18.08	15.15	1.096	1.020			1.354	1.274
			1/4 "	9.00	7.57	1.555	1.420			1.256	1.209

TABLE 4

Ring wear

A-alcohol motor fuel No. 1 with X-C upper cylinder lubricant and X-AA crank case oil

RINGS / PISTONS	RING 1	RING 2	RING 3	(SCRAPE) RING 4	WEAR FOR EACH PISTON
	gram	*gram*	*gram*	*gram*	*gram*
1	0.0320	0.0210	0.0216	0.0273	0.1019
2	0.0600	0.0419	0.0337	0.0323	0.1679
3	0.0546	0.0405	0.0368	0.0261	0.1580
4	0.0228	0.0146	0.0199	0.0084	0.0657
Total	0.1694	0.1180	0.1120	0.0941	0.4935
A-alcohol motor fuel No. 1 with Y-A crank case oil					
1	0.0980	0.0818	0.0864	0.0801	0.3463
2	0.1327	0.1328	0.1276	0.1001	0.4932
3	0.0891	0.0588	0.0586	0.0471	0.2536
4	0.0990	0.1411	0.1419	0.3051	0.6871
Total	0.4188	0.4145	0.4145	0.5324	1.7802
B-dehydrated alcohol with X-C upper cylinder lubricant and X-AA crank case oil					
1	0.0192	0.0261	0.0268	0.0307	0.1028
2	0.0361	0.0266	0.0430	0.0188	0.1245
3	0.0369	0.0163	0.0152	0.0200	0.0884
4	0.0219	0.0113	0.0106	0.0327	0.0765
Total	0.1141	0.0803	0.0956	0.1022	0.3922
B-dehydrated alcohol with Y-A crank case oil					
1	0.0586	0.0550	0.0532	0.0612	0.2280
2	0.0898	0.1354	0.1313	0.1146	0.4711
3	0.0919	0.0746	0.0705	0.0830	0.3200
4	0.0556	0.0391	0.0439	0.0554	0.1940
Total	0.2959	0.3041	0.2989	0.3142	1.2131
Gasoline with Y-A crank case oil					
1	0.0218	0.0239	0.0233	0.0168	0.0858
2	0.0477	0.0688	0.0495	0.0275	0.1935
3	0.0619	0.0425	0.0427	0.0365	0.1836
4	0.0282	0.0193	0.0190	0.0203	0.0868
Total	0.1596	0.1545	0.1345	0.1011	0.5497

TABLE 5

Carbon deposit in International engine

	A-ALCOHOL MOTOR FUEL NO. 1		B-DEHYDRATED ALCOHOL		GASOLINE WITH Y-A
	With X-C and X-AA	With Y-A	With X-C and X-AA	With Y-A	
	grams	*grams*	*grams*	*grams*	*grams*
Cylinder heads .	4.1062	4.6153	4.8994	5.1529	5.0893
Piston heads ...	1.1261	1.1825	0.6488	1.1456	1.2513
Piston walls ...	0.0371	0.0395	0.0363	0.0239	0.0547
Piston rings ...	0.0130	0.0026	0.0194	0.0279	0.0336
Ring grooves ...	0.2826	0.0775	0.2748	0.0671	0.1999
Valves	0.2608	0.5970	0.1431	0.2339	0.2229
Spark plugs	0.0184	0.0205	0.0046	0.0139	0.0197
Total	5.8442	6.5349	6.0264	6.6652	6.8714

TABLE 6

Viscosities of oil used

OIL USED	TESTS	130° F.				210° F.			
		1	2	3	Mean	1	2	3	Mean
X-AA	....	247.0	248.0	249.2	248.1	63.2	62.3	62.6	62.7
Y-A	....	267.6	266.8	263.2	265.9	67.8	67.8	67.0	67.6
Y-A	B-dehydrated alcohol								
	10 hours test	301.4	301.9	302.0	301.8	74.5	76.0	75.8	75.4
	8 hours test	286.0	285.2	283.8	285.0	70.0	70.2	70.0	70.1
X-AA	B-dehydrated alcohol								
	10 hours test	273.7	273.2	276.0	274.3	66.0	66.0	66.1	66.0
	8 hours test	263.5	268.8	259.8	264.0	64.5	64.2	64.7	64.5
Y-A	A-alcohol motor fuel No. 1								
	10 hours test	289.2	290.0	290.5	289.9	70.8	70.5	71.8	71.0
	8 hours test	282.0	280.1	284.8	282.3	67.2	67.0	66.8	67.0
X-AA	A-alcohol motor fuel No. 1								
	10 hours test	286.7	283.3	289.2	286.4	69.0	71.4	71.0	70.5
	8 hours test	262.3	259.3	259.8	260.5	64.7	65.0	64.9	64.9
Y-A	Gasoline								
	10 hours test	231.5	225.8	230.0	229.1	65.5	66.6	66.0	66.0
	8 hours test	218.7	221.7	220.0	220.1	64.3	66.0	65.5	65.3

TABLE 7

Power and fuel economy at fractional loads using A-alcohol motor fuel No. 1, B-dehydrated alcohol, and gasoline at 2200 r.p.m., 1600 r.p.m., and 1000 r.p.m.

FUEL	LOAD	BRAKE HORSEPOWER			RATE OF FUEL CONSUMPTION IN LB./B.H P.-HR.			MAXIMUM POWER DEVELOPED IN TERMS OF GASOLINE			FUEL CONSUMPTION IN TERMS OF GASOLINE		
		At 2200 r.p.m.	At 1600 r.p.m.	At 1000 r.p.m.	At 2200 r.p.m.	At 1600 r.p.m.	At 1000 r.p.m.	At 2200 r.p.m.	At 1600 r.p.m.	At 1000 r.p.m.	At 2200 r.p.m.	At 1600 r.p.m.	At 1000 r.p.m.
Gasoline	Full load .	49.00	39.85	25.32	0.592	0.557	0.593	100.00	100.00	100.00	1.000	1.000	1.000
	3/4 " ..	36.75	29.88	19.00	0.588	0.563	0.600				1.000	1.000	1.000
	1/2 " ..	24.48	19.94	12.66	0.785	0.682	0.710				1.000	1.000	1.000
	1/4 " ..	12.28	10.00	6.34	1.271	1.060	1.101				1.000	1.000	1.000
A-alcohol motor fuel No. 1	Full load .	49.50	41.00	25.71	0.982	0.952	1.121	101.02	102.88	101.14	1.515	1.561	1.724
	3/4 " ..	37.12	31.45	19.25	1.036	1.006	1.186				1.609	1.631	1.804
	1/2 " ..	24.75	20.48	12.84	1.309	1.289	1.495				1.523	1.727	1.922
	1/4 " ..	12.37	10.26	6.42	2.132	2.047	2.805				1.533	1.762	2.329
B-dehydrated alcohol	Full load .	48.60	40.90	25.70	0.970	0.923	1.048	99.18	102.63	101.10	1.440	1.532	1.634
	3/4 " ..	37.75	30.74	19.58	0.907	0.880	0.965				1.427	1.445	1.487
	1/2 " ..	25.11	20.47	13.04	1.196	1.173	1.347				1.410	1.588	1.756
	1/4 " ..	12.56	10.26	6.50	1.982	2.281	2.864				1.442	1.991	2.406

PROTEIN SUPPLEMENTS IN POULTRY RATIONS: V. COPRA MEAL AS A SUPPLEMENT IN RATIONS FOR GROWING CHICKS[1]

F. M. FRONDA AND MANUEL P. MALLONGA

WITH ONE CHART

Copra meal, a by-product obtained after the oil has been extracted from copra, is cheap and easily procured in this country. This by-product contains all of the food elements in satisfactory amounts and its content of proteins is fairly high (Santos, 1920; Caray, 1921). Experiments have shown that copra meal is an efficient protein concentrate (Fingerling, 1909; Skelton, 1911; Cranfield, 1912; Carlier, 1913); and its effectiveness as a supplementary feed has also been demonstrated (Lindsey, 1914; Maynard and Fronda, 1921). Because of these studies copra meal is extensively used as a protein supplement for live stock and poultry.

As a supplement in laying rations, Fronda (1919) working with laying hens, and Goseco (1921) with ducks, reported that copra meal was much inferior to snails. Serrano (1927) observed that hens fed with a ration containing copra meal gained in weight but the egg production of these hens was less than that of hens fed with dried shrimps. Taleon (1924) who made a study on the effect of copra meal as a mash supplement in a ration for laying hens observed that the hens that received no copra meal laid more eggs than those that received 10 per cent copra meal in the ration. He also reported that the birds that were fed with the ration that contained 10 per cent copra meal gained more in weight than those that received the ration without copra meal.

Using copra meal in different amounts as the sole protein supplement in rations for laying hens, Crucillo (1926) reported that this concentrate may be used as a supplement in laying rations provided that it forms not more than 30 per cent of the ration. Working with chicks, Mariano (1923) observed that chicks fed a ration containing

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[1] The data presented in this paper were taken from the thesis presented by the junior author for graduation March, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 459; Experiment Station contribution No. 1050. The thesis was prepared under the direction of Dr. F. M. Fronda, Assistant Professor of Poultry Husbandry.

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20 per cent copra meal may do well if the ration is supplemented with mungo and meat. No study has yet been reported regarding the influence of copra meal as the only protein supplement in chick rations.

To study this phase of protein supplements the writers carried out the experiment reported in this paper. In the experiment they attempted to answer the following questions: (*a*) What will be the effects on growth and mortality of chicks with copra meal as the sole supplement in their rations? (*b*) In what proportion should copra meal be added to the basal feed to give the best results? Without doubt, the answers to these questions will be of interest and possible value to poultry raisers.

PLAN OF THE STUDY

Los Baños Cantonese chicks were used in this experiment. There were three sets of observations made and each set covered a period of three months. The first set was started on January 9, 1933, and closed on April 3, 1933. This set consisted of 136 chicks which were divided into eight lots of 17 chicks each. The second set was started on May 9, 1933. This set consisted of 176 chicks which were divided into eight lots of 22 chicks each. This set was closed on August 3, 1933. The third set consisted of 128 chicks, divided into eight lots of 16 chicks each. This set was started on June 16, 1933. The last weighing of the chicks in this lot was on September 30, 1933.

All the chicks were raised in fireless brooders which were kept in individual brooding quarters on the range. Each of the brooding quarters had a grassy yard in which the chicks had free access to green feeds.

Rice bran, corn meal and copra meal were the feeds used. The approximate analyses of the feeding materials used in this experiment were as follows:

	RICE BRAN	CORN MEAL	COPRA MEAL [a]
	per cent	*per cent*	*per cent*
Moisture	10.79	12.84	14.41
Ash	11.13	1.30	4.81
Proteins	11.46	9.37	19.14
Crude fiber	12.14	1.81	18.49
N. F. E.	45.10	69.77	31.45
Fat	9.38	4.91	11.70

[a] Analysis by the Department of Agricultural Chemistry.

The basal part of the ration mixture consisted of three parts rice bran and one part corn meal, by weight; the protein supplement consisted of copra meal alone. The ration for the different lots was as follows:

LOT NO.	RATION MIXTURES IN PARTS BY WEIGHT	
	Basal portion (rice bran and corn meal)	Protein supplement (copra meal)
	parts	*parts*
I	95	5
II	90	10
III	85	15
IV	80	20
V	75	25
VI	70	30
VII	65	35
VIII	60	40

By computation, based on the analysis of the feeds, the amount of proteins in 100 kgm. of the different rations was:

LOT NO.	AMOUNT OF PROTEINS SUPPLIED FROM COPRA MEAL	TOTAL PROTEINS IN THE RATION
	kgm.	*kgm.*
I	0.95	11.34
II	1.91	11.75
III	2.87	12.16
IV	3.82	12.56
V	4.78	12.98
VI	5.74	13.39
VII	6.69	13.79
VIII	7.65	14.21

The rations were given in the form of all mash. The chicks had free access to the mash which was given in troughs kept open during the day. Fresh water, which was changed four times a day, was always in their drinking troughs.

The chicks were weighed soon after the different lots were formed and every seven days thereafter up to the twelfth week, when the observations were closed. The condition and health of the chicks in each lot were observed throughout the experiment. The amount of feeds consumed and the mortality in each lot were also recorded.

RESULTS AND DISCUSSIONS

Growth of chicks. The weekly weight of the chicks at different ages was used as the criterion in determining the effect of the rations on their rate of growth. The average weekly weights of the chicks during the brooding period are shown in table 1 and in chart 1. By reference to this table and to the chart, it may be seen that there was not much difference in the initial weights of the chicks in the different lots, the range being from 24.8 to 25.2 grams. In general, from the first week up to the age of four weeks there was no appreciable difference in the rate of growth of the chicks in the different lots. Of all the lots, however, lot IV registered the most rapid rate of growth up to the twelfth week; the chicks in this lot being the heaviest of all the lots studied. Lot II was second, lot V, third, lot VI was fourth. These differences were evidently due to differences in the amount of copra meal used in the rations.

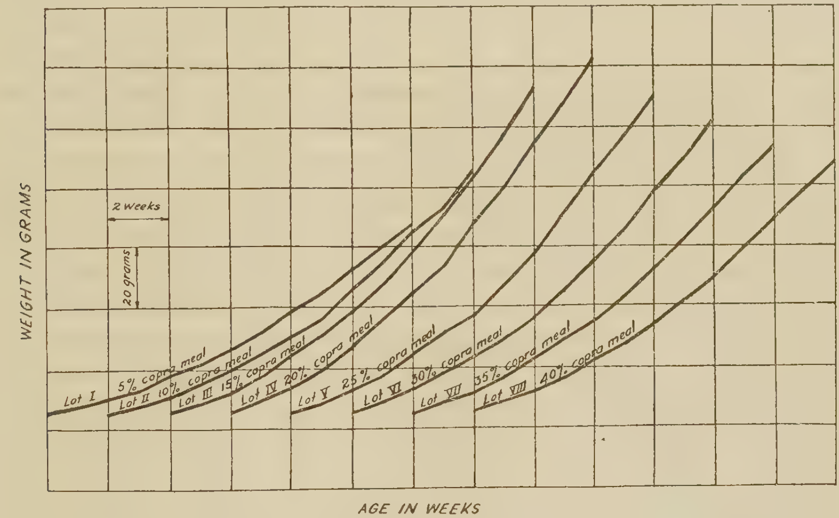

Chart 1.—Showing the rate of growth of the chicks in the different lots studied.

When the differences between the weights of the chicks at different ages were compared, it was observed that there was no appreciable difference in the lots from the first week up to the fourth, except in lots I and II. When the means of the weights of the chicks in these lots at the ages of three and four weeks were compared with that of lot IV which was apparently the best lot, it was found that the differences were significant. At the age of six weeks, the differences between the average weights of the chicks in the different lots when compared with that of lot IV were as follows: lot I, 18.0 ± 1.525 grams; lot II, 13.4 ± 1.493 grams; lot III, 5.5 ± 1.732 grams; lot V, 6.8 ± 1.671 grams; lot VI, 7.0 ± 1.847 grams; lot VII, 8.5 ± 2.200 grams; and lot VIII, 9.9 ± 2.492 grams.

The superiority of lot IV to the other lots remained consistent from the beginning of the experiment to the end of the twelfth week. Comparing lot IV with the other lots at the age of twelve weeks, it was found that the differences were statistically significant. For instance, the difference between lot IV and lot I was 54.0 ± 3.361 grams; that of lot IV and lot II, 36.5 ± 3.485 grams; lot IV and III, 9.3 ± 1.782 grams; lot IV and V, 12.1 ± 2.442 grams; lot IV and VI, 19.8 ± 2.419 grams; lot IV and VII, 27.6 ± 6.822 grams; lot IV and lot VIII, 33.0 ± 7.763 grams.

From these results, it may be seen that as the amount of copra meal in the ration was increased up to 20 per cent of the ration there was a corresponding increase in the rate of growth of the chicks. With from 20 to 40 per cent there was a corresponding decrease, but the weights did not go down as low as in lots I and II where the amount was 5 and 10 per cent, respectively. The results indicate that 20 per cent of copra meal may be the optimum amount to feed to growing chicks. The chicks that received this ration were observed to be more vigorous than the chicks in the other lots, although they were very much smaller than the chicks that received the normal rations (Fronda and Kabigting, 1934; Fronda and San Pedro, 1934).

The efficiency of the different rations were compared, using the size of the chicks at the age of twelve weeks as the basis of comparison. In this comparison, the weights of the chicks that were fed the ration containing 20 parts copra meal in every 100 kgm. of feeds was considered as 100 per cent. It was observed that if the weight of the chicks in lot IV was considered as 100 per cent, those of the other lots were as follows: lot III, 93.4 per cent; lot V, 91.5 per cent; lot VI, 86.1 per cent; lot VII, 80.4 per cent; lot VIII, 76.8 per cent; lot II, 74.3 per cent; and lot I, only 62.0 per cent.

Amount of feed consumed. Table 2 shows the amount of feed consumed in two weeks, computed on the basis of 100 chicks. By reference to this table it may be seen that there was no marked difference in the amount of feeds consumed by the different lots that were under observation. The average total amount of feed consumed per chick in the whole brooding period of 12 weeks was 1.27 kgm. for lot I; 1.30 kgm. for lot II; 1.33 kgm. for lot III; 1.34 kgm. for lot IV; 1.34 kgm. for lot V; 1.33 kgm. for lot VI; 1.33 for lot VII; and 1.32 kgm. for lot VIII.

Paje (1927) using a normal brooding ration reported that the total grain and mash consumption of every 100 birds up to twelve weeks of age was 142.33 kgm. This amount, however, does not include the 94 eggs that were fed to the chicks during the first four weeks of the brooding period.

Comparing the results obtained in this study with those found by Paje (1927), it may be observed that the feed consumed by the chicks in the different lots in the present study was a little less. Possibly, the chicks ate less because the rations used in this experiment were not as palatable as the ones used by Paje. Tuason and Fronda (1924) tested the palatability of the feeds available in the Philippines and reported that chickens did not find copra meal palatable. Amon (1930) in his experiment on the influence of free choice of feed in poultry feeding reported that up to the end of the twelfth week the least individual consumption of all the feeds he used was that of copra meal.

Mortality of chicks. Table 3 shows the comparison of mortality of the chicks in the different lots. As may be seen from this table the rather heavy mortality in all lots may be partly due to the effect of the feed upon the health of the chicks. Lot III, 15 per cent copra meal lot, had the lowest percentage of mortality, 33.80 ± 3.805 per cent, and lot VIII, 40 per cent copra meal lot, had the highest, 84.09 ± 5.384 per cent. The cause of the high percentage of mortality in lots having a high percentage of copra meal may have been due to constipation, judging by the feces voided by the chicks. In this connection, Derecho (1921) reported that copra meal fed alone or supplemented with purified food was highly constipating for guinea pigs. Sulit (1926a, 1926b) reported that when copra meal forms a large percentage of an otherwise complete ration, it is fatally toxic to both guinea pigs and albino rats. Mariano (1923) reported a higher percentage of mortality among chicks receiving 40 to 50 per cent copra meal than when given less.

Minor observations. In all the lots studied in this work, the following general conditions were observed. All the chicks were rather thin and too small for their age, although they were all fairly active. At the age of six weeks, only a few birds in the different lots had grown their primary wing feathers. The rate of growth of feathers was so slow that in most cases only a few of the birds were fully feathered even at the age of twelve weeks. The color of feces in the different lots varied greatly; that of the chicks in lots I and II was black; of lots III and IV, light brown, and of lots V, VI, VII, and VIII, hard and dark brown. The chicks had yellow shanks and beaks.

SUMMARY AND CONCLUSION

The effect of different amounts of copra meal in rations for growing chickens was studied. The rations tested contained, in addition to the basal mash, the following amounts of copra meal, lot I, 5.0 per cent; lot II, 10.0 per cent; lot III, 15.0 per cent; lot IV, 20.0 per cent; lot V, 25.0 per cent; lot VI, 30.0 per cent; lot VII, 35.0 per cent; lot VIII, 40.0 per cent. The results obtained were as follows:

1. The chicks that received 20 per cent copra meal in the ration attained the greatest weight at the age of twelve weeks.
2. It was observed that as the amount of copra meal in the ration increased up to 20 per cent, there was a corresponding increase in the rate of growth of the chicks. From 20 to 40 per cent the rate of growth decreased but not so low as that of 5 and 10 per cent.
3. The chicks that received 15 per cent of copra meal in the ration had the lowest percentage of mortality, 33.80 per cent, and those that received 40 per cent had the highest, 84.09 per cent.
4. Considering the size of the chicks at the age of 12 weeks as a basis, the different rations tested ranged in their efficiency as follows: if the weight of the chicks in lot IV was considered 100 per cent, that of lot III was 93.4 per cent; lot V, 91.5 per cent; lot VI, 86.1 per cent; lot VII, 80.4 per cent; lot VIII, 76.8 per cent; lot II, 74.3 per cent; and lot I, only 62.0 per cent.
5. There was not much difference in the amounts of feed consumed by the different lots.
6. All the chicks were thin and were much under size for their age.
7. Taking all effects into consideration, copra meal can not be considered a good source of protein for growing chicks. If it is used at all it should not form more than 15 to 20 per cent of the total ration.

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TABLE 1

Showing the average weekly weights of the chicks in the different lots

AGE	LOT I (5% COPRA MEAL)		LOT II (10% COPRA MEAL)		LOT III (15% COPRA MEAL)		LOT IV (20% COPRA MEAL)	
	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight
		grams		*grams*		*grams*		*grams*
Day old	55	24.8 ± 1.133	55	25.0 ± 1.130	55	25.2 ± 1.160	55	25.0 ± 1.120
1 week	49	27.1 ± 1.203	50	27.4 ± 1.171	53	28.0 ± 1.194	46	28.7 ± 1.268
2 weeks	45	30.0 ± 0.713	47	30.3 ± 0.746	50	32.0 ± 1.081	45	33.3 ± 1.329
3 weeks	45	33.1 ± 0.574	45	34.4 ± 0.556	48	37.4 ± 0.621	43	39.5 ± 0.897
4 weeks	42	37.3 ± 0.620	44	39.9 ± 0.830	47	44.2 ± 1.201	41	47.1 ± 1.554
5 weeks	40	41.1 ± 0.252	40	45.1 ± 0.573	47	51.5 ± 1.298	39	55.8 ± 1.518
6 weeks	36	45.9 ± 0.749	39	50.5 ± 0.681	45	58.4 ± 1.112	36	63.9 ± 1.329
7 weeks	31	52.0 ± 1.180	34	57.3 ± 1.228	41	68.0 ± 1.030	35	73.7 ± 1.160
8 weeks	27	58.8 ± 1.489	31	66.5 ± 1.433	40	79.3 ± 1.045	34	86.7 ± 1.329
9 weeks	25	65.0 ± 1.531	31	74.6 ± 2.084	39	91.1 ± 1.797	32	99.2 ± 1.720
10 weeks	21	72.7 ± 2.543	28	85.1 ± 2.354	37	104.4 ± 1.720	30	113.9 ± 1.855
11 weeks	20	80.0 ± 2.428	26	94.5 ± 3.204	37	118.0 ± 1.398	30	126.8 ± 2.280
12 weeks	20	88.0 ± 2.968	26	105.5 ± 3.107	37	132.7 ± 0.829	30	142.0 ± 1.578

TABLE 1 (Continued)

AGE	LOT V (25% COPRA MEAL)		LOT VI (30% COPRA MEAL)		LOT VII (35% COPRA MEAL)		LOT VIII (40% COPRA MEAL)	
	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight	Number of chicks	Average weight
		grams		*grams*		*grams*		*grams*
Day old	55	24.9 ± 1.212	55	25.2 ± 1.187	55	25.1 ± 1.167	55	25.2 ± 1.167
1 week	48	28.1 ± 1.348	46	28.4 ± 1.164	44	28.3 ± 1.125	41	28.2 ± 0.874
2 weeks	43	33.1 ± 1.420	39	32.4 ± 1.031	36	31.3 ± 1.086	34	31.8 ± 0.977
3 weeks	40	38.0 ± 0.740	39	37.5 ± 0.315	34	36.4 ± 0.813	29	36.1 ± 0.557
4 weeks	36	45.0 ± 1.260	35	43.5 ± 1.096	31	42.6 ± 1.697	28	42.1 ± 1.584
5 weeks	32	51.8 ± 1.446	34	50.4 ± 1.488	29	48.8 ± 2.249	24	47.5 ± 2.380
6 weeks	30	57.1 ± 1.014	31	56.9 ± 1.284	26	55.4 ± 1.753	22	54.0 ± 2.108
7 weeks	28	66.9 ± 1.012	30	64.8 ± 1.537	24	62.8 ± 1.949	17	61.4 ± 2.263
8 weeks	27	78.2 ± 1.294	28	75.1 ± 1.658	21	71.6 ± 2.146	14	69.0 ± 1.897
9 weeks	26	90.2 ± 1.824	26	85.6 ± 2.075	18	81.4 ± 2.659	10	79.5 ± 3.831
10 weeks	25	103.9 ± 2.018	25	98.3 ± 1.824	15	92.7 ± 4.849	9	88.9 ± 4.509
11 weeks	25	116.2 ± 2.370	24	109.0 ± 2.172	15	103.3 ± 5.656	9	98.7 ± 4.079
12 weeks	25	129.9 ± 1.864	24	122.2 ± 1.834	14	114.2 ± 6.637	9	109.0 ± 7.595

TABLE 2

Showing the average amount of feed consumed; computation based on 100 chicks

PERIODS	LOT I	LOT II	LOT III	LOT IV	LOT V	LOT VI	LOT VII	LOT VIII
	Mash	Mash	Mash	Mash	Mash	Mash	Mash	Mash
	kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
2 weeks	9.1	9.5	10.1	10.3	10.4	10.1	10.2	9.9
4 weeks	14.3	14.6	15.2	15.0	15.1	14.8	14.9	15.0
6 weeks	19.9	20.5	21.1	21.1	21.3	21.1	21.0	20.9
8 weeks	24.3	24.6	25.2	25.5	25.3	25.3	25.0	25.0
10 weeks	28.3	28.7	29.3	29.4	29.3	29.3	29.3	29.1
12 weeks	31.3	31.8	32.1	32.3	32.4	32.4	32.3	32.3
Total	127.2	129.7	133.0	133.6	133.8	133.0	132.7	132.2

TABLE 3

Showing the percentage of mortality of chicks in the different lots up to 12 weeks old

LOT NO.	TRIALS			AVERAGE
	1	2	3	
	per cent	*per cent*	*per cent*	*per cent*
I	70.59	54.54	68.75	64.63 ± 3.420
II	52.95	50.00	62.50	55.15 ± 2.544
III	41.18	22.72	37.50	33.80 ± 3.805
IV	41.18	45.45	50.00	45.54 ± 1.717
V	64.71	45.45	56.25	55.47 ± 3.965
VI	70.59	45.45	56.25	57.43 ± 4.560
VII	100.00	63.64	62.50	75.38 ± 8.303
VIII	100.00	77.27	75.00	84.09 ± 5.384

ROBERT L. PENDLETON: AN APPRECIATION[1]

"What a tale of patience, courage, sacrifice, and martyrdom, is the history of human progress", thus commented a great English scholar. I consider it a distinct privilege to write about a man, who although not a martyr, possesses the attributes, "patience, and courage". I refer to Dr. Robert L. Pendleton, Professor of Soil Technology and first Head of the Department of Soils in the College of Agriculture.

I write of Professor Pendleton as a public acknowledgment, an appreciation, although in an inadequate way, of his sterling qualities and of his meritorious work on the soils of the Philippines and of the service he gave for the good of the College and of his students. For more than a decade, he worked faithfully to place studies on soils in the Philippines on the map of progress. He labored earnestly to organize and develop to the highest point of effectiveness the courses on soils in the College. For these efforts I believe Doctor Pendleton merits the admiration and gratitude of the Filipino people and more particularly of the College constituency. If credit is given to whom credit belongs, credit certainly goes to him in no small way.

Professor Pendleton came to the College of Agriculture at Los Baños about twelve years ago, on September 26, 1923, to be exact. He came from India where he, for seven years, was Director of Agriculture in the State of Gwalior. After about nine years of continuous service in the College of Agriculture at Los Baños, to break staleness and to gain more experience outside of the Philippines, Doctor Pendleton went on leave for one year without pay. He spent this year working for the National Geological Survey of China. He again served the College for the next two or three years; recently resigning to enable him to make a new venture in soil work in Siam under the new government. Thus, it may be said that Professor Pendleton is a missionary in science—in soil survey and other phases of studies on soils. His field has been in Asia, and almost wholly in tropical regions.

The resignation of Professor Pendleton means a loss to the College, to the country and to our young men, who may want to study the phase of soils which was his specialty—survey in the field. Doctor Pendleton's years in Los Baños were fruitful. Patience, courage and continuous effort made his twelve years on the College faculty a very productive period in the interest of soil science in the Philippines. His article on the history of soil science in the August issue of this journal briefly reviews his work. In the past two years, Doctor Pendleton made three trips in the Islands—soil observation trips they might be called. Fortunately, he recorded these trips in articles which were published in this journal. In the Soils Department he organized various courses; among them, *Elementary Soils*, on *Soil Management and Soil Survey*, on *Soil Fertility and Fertilizers*, and *Seminar* and *Researches on Soils.* In severing his connection with the College at this time, Professor Pendleton deeply regrets, he confided to me, that owing to the limited appropriation allotted yearly to his department, he had not been able to train more young men to do soil survey work in the Philippines. He fears that one of his pet dreams, a thorough soil survey of all agricultural lands in the Philippines, may not be realized for many, many years.

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[1] General contribution from the College of Agriculture No. 498.

Doctor Pendleton is a very likeable man. He knows how to fall in—how to cooperate. While with us, he served on various committees. He helped in no small measure to advertise the College and its work by means of photographic illustrations prepared by himself or under his supervision. He played the rôle of "sustaining" member in one of the faculty sporting clubs on the campus, regularly paying his fees and dues, although he himself had no time or the inclination to indulge in athletics. During the Sakdal uprising, Doctor Pendleton once more showed his loyalty to the College community. He took an active part in guard duty, passing the nights practically without any sleep. Thus, Doctor Pendleton proved himself a man among men. His thesis and field work students will always treasure the memory of Doctor Pendleton's kindly thoughtfulness in taking them when possible in his motor car to their work. In this work "official time" did not figure. He wanted the work done.

As additional aids to better teaching and research, Professor Pendleton is a member of a number of scientific societies that issue technical publications. He is a member of the International Society of Soil Science, American Soil Survey Association, American Chemical Society, American Society of Agronomy, American Association for the Advancement of Science, American Geographical Society, China Geological Society, Peking Natural History Society, and Indian Botanical Society.

In scientific research, especially on soils in the tropics, Professor Pendleton has been productive. In the general field, he tackled the "field study, survey, classification and mapping of soils, particularly those of the tropics". In related fields, he was engaged in the study of the "utilization of soils, and their responses to certain amendments, fertilizers, and treatments". He also studied "the relationship of soil to certain crop and forest covers". "Soil erosion and its control, and the relation of erosion to reforestation and afforestation" were likewise studied while he was in Los Baños. More than forty-three separate articles or reports of results of his studies have been published in various journals.

Doctor Pendleton sailed for Siam on June 24. He will obtain leave in July to attend the International Conference of Soil Technologists which meets in London in August. In connection with the conference there are several soil trips planned throughout England and Scotland.

RAFAEL B. ESPINO
Of the Department of Plant Physiology

ABSTRACTS[1]

A study of coffee propagation by cuttings. BRICCIO O. REYNOSO. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 460; Experiment Station contribution, No. 1051.*)—The author worked on three objects: (1) to study coffee propagation by cuttings; (2) to determine which soil medium is best suited for rooting coffee cuttings; and (3) to determine the difference between softwood and hardwood cuttings in their ability to produce roots.

In the experiment, 12,000 cuttings of *Coffea robusta* Linden were used, 6,000 were softwood cuttings made from immature upright branches with green bark and 6,000 were hardwood cuttings made from mature upright branches with brown bark. The soil media used were sand, combination of equal parts sand and ordinary garden soil, ordinary garden soil and forest soil.

Twenty-four plots, each 5 × 1 m., were prepared at three stations having different elevations. Two plots for every one of the four soil media were used at each of the three stations. The author planted 500 softwood cuttings in one plot and 500 hardwood cuttings in another, making 1,000 cuttings for each medium at each station. The number of leaves developed were counted weekly and one year after planting the cuttings were dug out and examined for root formation.

The author found that: (1) Under field conditions, the two types of cuttings of Robusta coffee produced roots. (2) Under field conditions, the softwood cuttings required at least three to six weeks to develop leaves and the hardwood, five to nine weeks. (3) Garden soil was the best medium for rooting the hardwood cuttings and sand for the soft wood. (4) Hardwood cuttings produced more long roots than softwood.

It was recommended that for propagation, hardwood cuttings made from mature uprights with brown bark were to be preferred to softwood cuttings.

—*Abstract by Amado F. Costes*

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[1] Abstracts prepared as part of theme work required in English 3a, College of Agriculture.

Variety tests and cost of production of seven varieties of peanut. ANGEL T. BATTUNG. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 461; Experiment Station contribution No. 1052.*) —This study included the wet and dry season cultures and was carried out in the College of Agriculture, Los Baños, Laguna. The objects of the experiment were to determine the best variety or varieties of peanut to grow under Los Baños conditions and to determine the cost of production. The varieties used were Kinorales, Lemery, Spanish Red, Spanish White, Tarlac, Valencia, and Vigan Lupog. In both cultures the land was plowed twice before sowing the seeds. To have a fair comparison, the seeds in both cultures were selected.

Two seeds were planted in hills 60 cm. apart in rows one meter apart. Three plots of 10 by 15 meters were planted for each variety. The culture plots for the wet season were hoed twice, the first hoeing being 20 days after planting. Plowing was done to throw the soil up along the rows. This operation provided loose earth for the development of the pods. The furrows acted as drainage for the wet season culture. The dry season culture received the same treatment except that weeding was done only once.

The wet season crop matured in 122 days, the dry season crop in 110 days. In both cultures, Valencia yielded the most in pods, Spanish White, second, and Lemery, third. Tarlac and Spanish Red varieties were the poorest yielders. The wet season production was 686.09 kgm. of pods, 673.94 kgm. of straw per hectare with ₱86.57 as cost of production on basis of one hectare; the dry season culture gave 692.33 kgm. of pods and 674.89 kgm. of straw, the cost of production being ₱77.22, also on the basis of one hectare. The cost of production was higher in the wet than in the dry season culture, owing to the cost of additional weeding in the wet season.

—Abstract by Crispulo U. Pangramuyen

CURRENT NOTES

One of the things puzzling to me sometimes is why in our search for rubber trees with high yielding strains we have never gone back to Brazil, whence came the plants from which all rubber trees in the middle East are descended. In this country [F.M.S.] alone there are at least three hundred million trees, the progeny of a chance pick in the Brazilian forests by Sir Henry Wickham some sixty years ago. There was never any suggestion that Wickham made a careful selection from high yielders. On the contrary, it seems, reading back, that he made a secret collection of seeds and burglariously shipped them out of the country in great fear of being caught and made to disgorge.

The Planter (F.M.S.), April, 1935.

From the United States comes the claim that their annual loss from insects is £700,000,000, and from weeds £600,000,000, both surely preventable, at least to a vast extent. Records of the insect Pest Survey show that 34 of these little beasts alone cause a known damage of £185,000,000, with the boll weevil leading with £33,000,000.

Tropical Life, April, 1935.

For many centuries writers on horticulture and agriculture have, almost without exception, emphasized the importance of thorough and deep cultivation in order to aërate the soil, to conserve moisture, and to increase the feeding ground for roots. Work of experiment stations has shown such ideas to be erroneous and that cultivation should be regarded as a necessary evil, not as an essential practice. There are four reasons why cultivation may have to be performed in orchards, namely; to prepare a seed bed in case a cover crop is planted; to mix fertilizers or organic matter with the soil; to kill weeds which compete with trees for moisture and plant food; and to prepare soil for the absorption of water whether from rain or from irrigation. Changes in pruning practices have been almost as radical as those in cultivation. The prevailing practice has been to prune young fruit trees heavily in order to make them grow vigorously. In California a change from the heavy system of pruning to a modified or long system gave marked results so that the Director of that Station concluded in his report for 1922 that "the annual income from California orchards has been increased a little less than seven million dollars." IRA J. CONDIT.

Lingnan Science Journal, April, 1935.

One of the results of the period of depression has been a drastic overhauling of the canning industries in the important producing countries, and it seems evident that they will emerge from these difficult times on a more keenly competitive basis than ever before. Hawaiian and Malayan pineapple are sufficiently dissimilar to preserve even yet the distinction between the markets for the two products, but in planning for the future it would certainly seem inadvisable to count on this distinction as a permanent feature; with

Australia, South Africa and Formosa also in the field and moreover on a much more nearly competitive basis, the need for reorganisation becomes even more pressing. This is quite apart from the competitive influence of other fruits which seems likely to grow stronger if and as the tastes of the consuming public change.

The Malayan Agricultural Journal, April, 1935.

Soak old newspapers in a strong solution of soda and hot water and squeeze it to a pulp. Stuff this in rat holes. The pulp will set like cement, and rats and mice will not eat it.

Queensland Agricultural Journal, April, 1935.

Drought resistance in plants is not a simple attribute, but the result of the interplay of a number of complex physiological factors. Some of these find expression in external morphological characters, such as reduced transpiring surface, hairiness, sunken stomata and others, which we call "xerophytic"; but more important are the internal factors, such as an increased osmotic pressure of the cell sap, which enables the plant to obtain sufficient water from heavily depleted soil reservoirs. It should not be overlooked, moreover, that the possession of a deep root system is just as much a xerophytic character under certain circumstances as, for example, succulence or a prostrate habit. Breeding for drought resistance is thus not a straightforward issue, but one requiring highly specialised knowledge, such as the Russian botanists have been pursuing with such energy during the past few years. This intricacy is but another facet to the general problem of water conservation, a problem urgently in need of greater cooperative effort on the part of engineers, botanists, soil chemists, meteorologists, physiologists and geologists alike. Thirty to forty years is none too long a period if agriculture is to be prepared to combat the next world drought in the rainfall cycle, better than it has weathered this one.

Tropical Agriculture (Trinidad, B. W. I.), October, 1934.

COLLEGE AND ALUMNI NOTES

On July 9 a delegation of eighteen Siamese government officials fifteen of whom are members of the National Assembly spent a day on the Campus. This delegation was in the Philippines on a tour of observation and investigation with the object of adding to their knowledge of the working of a representative government and its institutions.

At the Convocation of faculty and students Mr. Netra Bhunvivadhana, member of the National Assembly and leader of the delegation made a brief address in Siamese which was interpreted by Luang Thavil, Director, Information Bureau, Royal State Railway. Luang Thavil then spoke on the attractions of Siam for travelers.

There was special interest in the visit of this foreign delegation because of the fairly large number of Siamese students that have been graduated from this College in the past fifteen Years, Mr. Iang Chandrastitya and Mr. Thongdee Resananda the first two who graduated are in the Ministry of Agriculture; Mr. Resananda is Director. The other graduates are employed in the Experiment Stations and Agricultural Teachers' Training Schools.

Doctor R. B. Espino, head of the Department of Plant Physiology, returned June 17, 1935 from Lingnan University, Canton, China, where he occupied the position as exchange professor in plant physiology from March 14 to June 10, 1935. During his stay in that University, Doctor Espino offered courses in Biology 32 (Plant Physiology) and part of Agronomy 52 (Principal Crop Plants of Kwantung Province) in which he gave a series of lectures on coconut and fiber plants. During his spare time, he visited several Experiment Stations and the National Sun Yatsen University.

Dr. F. O. Santos, head Department of Chemistry has been invited by the School of Public Health and Nursing to give a series of ten lectures on nutrition this semester.

In the last meeting of the Biological Chemistry Section of the National Research Council, Dr. F. O. Santos was elected Chairman and Dr. A. I. de Leon Secretary of the section.

The Los Baños Chapter of the Rizal Center Fraternity elected Dr. Valente Villegas as the Supreme Noble for the current year. Doctors Leon Gonzalez, A. I. de Leon, F. O. Santos and Mr. Felix Sarao are the other officers of the Fraternity.

The Rizal Center is the oldest fraternity in the University and the only one with a Sorority Chapter as well as chapters here in Los Baños and in Cebu. Its aim is service to the University.

Plans are under way in the Los Baños Chapter for an interesting program of activities this year. In the past it has contributed in different ways to Campus life. The bandstand in the Athletic Field was begun on the initiative of the local chapter. It has been responsible for concerts by Manila artists. Last year the Fraternity donated money to the library of the Maquiling School and the Silver Anniversary celebration. A research fellowship is now being created by the Mother Chapter in Manila.

Mr. Pablo Aala '35 won first place in the college group in the Anti-Usury Essay contest. The honor carries with it a prize of ₱25. This contest is conducted by the chief of the division of educational and remedial propaganda of the Anti-usury Board. The topic assigned this year was "Ways to Reduce Usury in the Philippines." A student from the University of Sto. Tomas won second place and one from Silliman University, third place.

The Ranchers' Club elected the following officers for the first semester, 1935-1936:

Governor	Raymundo Laher
Lieutenant Governor	Ramon Mercado
Secretary	Celestino Quilang
Treasurer	Gaudencio Sacay
Sheriff	Guillermo Valdez
Adviser	Valente Villegas

The one-hundred-and-third regular scientific meeting of the Los Baños Biological Club was held in the Auditorium, College of Agriculture June 27, at 7:30 p. m.

The following papers were read and discussed:

"Hybridization and selection of cotton varieties"
By Dr. Jose A. Capinpin

"Impressions from a recent trip to China"
By Dr. Rafael B. Espino

"Studies on surra: III. A survey on the incidence of surra in the vicinity of the College of Agriculture with observations on numerical fluctuations of Tabanid flies."
By Dr. Miguel Manresa and Mr. Osmundo Mondoñedo
Paper read by Doctor Manresa

On the evening of July 10, 1935 the Mimics met and elected the following officers:

President	Miguel de Guzman
Vice-President	Romulo B. Gines
Secretary	Demetrio G. Miranda
Treasurer	Primo Castro
Stage Manager	Andres C. Caranto
Business Manager	Dionisio Abella

The admission of new members was discussed. There are two vacancies to be filled. Several names were submitted for consideration. The applicants will be especially tested in pronunciation and enunciation.

Active Members of the Mimics

Seniors:

1. M. E. Rosell
2. Concordio Mandac
3. Gabriel S. Flores
4. Demetrio G. Miranda
5. Jose E. Borromeo
6. Rasuman P. Macalandong
7. Andres C. Caranto
8. Miguel de Guzman
9. Romulo B. Gines
10. Celestino B. Quilang
11. Flaviano P. Olivares
12. Abel Silva
13. Francisco Gomez
14. Primo R. Castro

Juniors:

1. Vicente Lolingco
2. Aniceto O. Rollan
3. Benigno G. Talamisan
4. Prudencio C. Martin
5. M. G. Rana
6. Felix Remigio
7. Antonio Ocampo
8. Romeo Espino

Sophomores:

1. Dionisio M. Abella

Professor Anne F. Cole is Adviser of the Mimics by appointment.

The Secretary's office reports the following foreign students enrolled in the College of Agriculture for the academic year 1935-36.

China: (11)

1. Au-Yeng Helen (Miss)
2. Chan Shuk Yee (Miss)
3. Chan Ming Sau
4. Chau Kin
5. Cheung Sui Fong (Miss)
6. Kwan Tai Wai
7. Lee Pao Shan (Miss)
8. Pang Kwock-kee
9. So Tso Yum
10. Wong Shui Yan
11. Wong Tok Sau

Dutch East Indies: (2)

1. Effendi, Moechtar S.—Sumatra
2. Lim Gwan Tion—Java

Sarawak: (1)

1. Crocker, William

Siam: (15)

1. Bukkavesa, Sangtod
2. Chakrabandhu, Mom Chao
3. Emasiri, Saluey
4. Isarabhakdi, Abhai
5. Jalavicharana, Kan
6. Kashemsri, Mom R. A.
7. Kemayothin, Soratrya
8. Nadinandana, Chinda
9. Nakornthap, Arth
10. Natatat, Chalam
11. Pradipasen, Pradip
12. Pradipasen, Praduang
13. Punyasingh, Krui
14. Raktakanistha, Xom
15. Sarikabhuti, Preuang

THE FUTURE OF ENGLISH[1]

"The English tongue is of small reach, stretching no further than this island of ours, nay not there over all."

This was written in 1582. The writer was Richard Mulcaster, headmaster of the Merchant Taylor's School, teacher of prosody to Edmund Spenser, and one of the earliest of English grammarians. At the time he wrote, English was spoken by between four and five millions of people, and stood fifth among the European languages, with French, German, Italian, and Spanish ahead of it in that order, and Russian following. Two hundred years later Italian had dropped behind but Russian had gone ahead, so that English was still in fifth place. But by the end of the Eighteenth Century it began to move forward, and by the middle of the Nineteenth it had forced its way into first place. To-day it is so far in the lead that it is probably spoken by as many people as the next two languages—Russian and German—combined.

It is not only the first—and, in large part, the only—language of both of the world's mightiest empires; it is also the second language of large and populous regions beyond their bounds. Its teaching is obligatory in the secondary schools of countries as diverse as Germany and Argentina, Turkey and Denmark, Estonia and Japan. Three-fourths of all the world's mail is now written in it; it is used in printing more than half the world's newspapers, and it is the language of three-fifths of the world's radio stations. No ship captain can trade upon the oceans without some knowledge of it; it is the common tongue of all the great ports, and likewise of all the maritime Bad Lands, from the South Sea islands to the Persian Gulf. Every language that still resists its advance outside Europe —for example, Spanish in Latin America, Italian in the Levant, and Japanese in the Far East—holds out against it only by making large concessions to it. That is to say, all of them show a large and ever larger admixture of English words and phrases; indeed in Japanese they become so numerous that special dictionaries of them begin to appear. Finally, English makes steady inroads upon French as the language of diplomacy and upon German as the language of Science.

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[1] Excerpts from an article, "The Future of English," by H. L. Mencken in Harper's Monthly Magazine April, 1935.

PHILIPPINE AGRICULTURIST, VOL. XXIV, NO. 5, OCTOBER, 1935

How many people speak it to-day? It is hard to answer with any precision, but an approximation is nevertheless possible. First, let us list those to whom English is their native tongue. They run to about 112,000,000 in the continental United States, to 42,000,000 in the United Kingdom, to 6,000,000 in Canada, 6,000,000 in Australia, 3,000,000 in Ireland, 2,000,000 in South Africa, and probably 3,000,000 in the remaining British colonies and the possessions of the United States. All these figures are very conservative, but they foot up to 174,000,000. Now add the people who, though born to some other language, live in English-speaking communities and speak English themselves in their daily business, and whose children are being brought up to it—say 13,000,000 for the United States, 1,000,000 for Canada (where English is gradually ousting French), 1,000,000 for the United Kingdom and Ireland, and 2,000,000 for the rest of the world—and you have a grand total of 191,000,000.

Obviously, no other language is the everyday tongue of so many people. Russian is spoken as first choice by no more than 80,000,000 of the 150,000,000 citizens of the U. S. S. R.; the rest cling to one or another of the hundred odd lesser dialects in which the Bolsheviki are forced to print their official literature; and outside Russia, Russian is scarcely spoken at all, for the colonies of the U. S. S. R. lie without exception within its territorial bounds. German follows. It is spoken by 65,000,000 Germans in Reich, by perhaps 7,000,000 in Austria, by a scant 3,000,000 in German Switzerland, by perhaps 5,000,000 in the lost German and Austrian territories, and by another 5,000,000 in the German-speaking colonies in Russia, the Balkan and Baltic states, and South America. This makes 85,000,000 all together. Whether French or Spanish comes next is in doubt, but neither can show more than 55,000,000. Italian is the runner-up, and the rest of the European languages are nowhere. Nor is there any rival to English in Asia; for though Chinese is ostensibly the native tongue of more than 300,000,000 people, it is split into so many mutually unintelligible dialects that it must be thought of less as a language than as a group of languages. The same may be said of Hindustani. As for Japanese, it is spoken by no more than 70,000,000 persons, and thus lags behind not only English, but also Russian and German. As for Arabic, it probably falls below even Italian.

Thus English is far ahead of any competitor. Moreover, it promises to increase its lead hereafter, for no other language is spreading so fast or into such remote areas. There was a time when French was the acknowledged second language of all Christendom, as Latin had been before it, and even to this day, according to Dr.

Frank E. Vizetelly, the number of persons who have acquired it is larger than the number of those who have it by birth. But the advantages of knowing it tend to diminish as English conquers the world, and it is now studied as an accomplishment far more often than as a necessity. In Tzarist Russia nearly every child who got any education at all was taught it; but the Bolsheviki, who are realists, are now substituting English and German. In our own high schools and colleges French is retained in the curriculum, but it is hardly likely that more than five per cent of the students ever acquire any facility in it. In the Schools of Germany, Scandinavia, and Japan, however, English is taught with relentless earnestness, and a great deal of it sticks. Indeed, even the French begin to learn it.

How far it has thus gone as a second language it is not easy to determine, but a few facts and figures taken at random may throw some light on the question. Half a century ago it was little used in the lands and islands settled by the Spanish; the second language in all of them, in so far as they had any second language, was French. But the impact of the Spanish-American War has forced French to share its hegemony with English. The Latin-Americans still prefer French on cultural counts, for they continue to regard France as the beacon-light of Latin civilization, but they turn to English for the hard reasons of every day. This movement is naturally most marked in the areas that have come under direct American influence—for example, Cuba, the Isthmian region, and, above all, Porto Rico, where twenty per cent of the people now speak English—but it is also visible in Mexico, in Central America, and in the more progressive of the countries to the southward. In the Philippines, I am informed, fifteen per cent of the population of 15,000,000 now not only speak English, but also read it and write it.

All over the rest of the Far East it has been a *lingua franca* since the Eighteenth Century, at first in the barbarous guise of Pidgin English, but of late in increasingly seemly forms, often with an American admixture. In Japan, according to the Belgian consul-general at Yokohama, it is now "indispensable for all Europeans. One can do without Japanese, but would be lost without English. It is the business language." In China it has been established for many years, and in India, though only 2,500,000 natives can read and write it, it is the language not only of business but also of politics. Those Indians who know it, says Sir John Marriott in *The English in India* (1932) "are the only persons who are politically conscious.... The medium of all political discussion is necessarily English." And on the level of illiteracy it is fast becoming a bridge between the native dialects.

Altogether, it is probable that English is now spoken as a second language by at least 20,000,000 persons throughout the world—very often, to be sure, badly, but nevertheless understandably. It has become a platitude that one may go almost anywhere with no other linguistic equipment and get on almost as well as in New York. I have visited since the War sixteen countries in Europe, five in Africa, three in Asia, and three in Latin-America, beside a large miscellany of islands, but I don't remember ever encountering a situation that English could not resolve. I have heard it spoken with reasonable fluency in a Lithuanian village, in an Albanian fishing port, and at the edge of the Libyan Desert....

English, brought to close quarters with formidable rivals, has won very often, not by force of numbers and intransigence, but by the sheer weight of its merit. "In wealth, wisdom, and strict economy," said the eminent Jakob Grimm a century ago, "none of the other living languages can vie with it." To which the eminent Otto Jespersen was adding only the other day: "It seems to me positively and expressly masculine. It is the language of a grown-up man, and has very little childish or feminine about it." Dr. Jespersen goes on to specifications: English is simple, it has clear sounds, it packs its words closely together, it is logical in their arrangement, and it is free from all pedantic flubdub, by Latin out of the languages of Babel. What an immense advantage lies in a single thing: its lack of grammatical gender! (I spent the years from 1887 to 1892 trying to remember whether *Hund* and *Katze* were *der, die* or *das,* and I can't tell you to this day.) And what another in its reduction of all the pronouns of the second person nominative to the single *you!*...

No other European language has so many three-letter words, nor so many four-letter words, whether decorous or naughty. And none other can say its say with so few of them....

Several years ago an American philologian, Dr. Walter Kirkconnell, undertook to count the number of syllables needed to translate the Gospel of Mark into forty Indo-European languages, ranging from Persian and Hindustani to English and French. He found that, of all of them, English was the most economical, for it took but 29,000 syllables to do the job....

The huge English vocabulary is likely to make the foreigner uneasy, but he soon finds that nine-tenths of it lies safely buried in the dictionaries, and is never drawn on for everyday use. Its richness in synonyms is hardly his concern; he is not trying to write English poetry but to speak plain English prose. . . .

After the late war I went to Berlin full of a firm determination to improve my German, always extremely anaemic. I failed to get anywhere because practically all the Germans who interested me spoke very good English. A little while later Dr. Knut Sanstedt, general secretary of the Northern Peace Union, sent a circular to a number of representative European publicists, asking them "what language, dead or living or artificial" they preferred for international communications. Not one of these publicists was a native or resident of the British Isles, yet out of fifty-nine who replied thirty voted for English. Of the six Swedes, all preferred it; of the seven Norwegians, five; of the five Hollanders, four.

I have read the editorial comment of undergraduate periodicals in recent years with considerable care. I have listened to extended criticism of college procedures and of college accomplishments in undergraduate groups. In consideration of these with great interest and with some profit, I have nevertheless had much concern, as forecasting the temper of the great society which college men would later make up, that emphasis has been so largely placed upon what the colleges should do for their men and so little emphasis has been placed upon what these men should do for themselves. Much has been said about making the absorption of learning less difficult, the conditions of college life more comfortable, the procedures and programs more convenient, and the adverse judgments in regard to indolence and indifference less exacting. Little has been said about how learning should be made accurate, or about how mental fiber should be toughened, or about how intellectual fortitude should be developed. PRESIDENT HOPKINS, *Dartmouth College.*

What the Colleges are Doing, January, 1935.

"Gentlemen, you must light your own torch" said President Daniel U. Gilman in his welcoming address to the first "Student Body," twenty Fellows, of Johns Hopkins.

ALCOHOL AND ALCOHOL-GASOLINE BLENDS AS FUELS FOR AUTOMOTIVE ENGINES: III. PERFORMANCE TESTS OF ALCOHOL, GASOLINE, AND ALCOHOL-GASOLINE MIXTURES AS FUELS FOR AN EIGHT CYLINDER AUTOMOBILE ENGINE[1]

A. L. Teodoro
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WITH ONE TEXT FIGURE AND SEVENTEEN CHARTS

The purpose of this study is to determine the performance of an eight cylinder engine when gasoline, alcohol, and alcohol-gasoline mixtures are used as fuels. Two important points were considered, operating characteristics and fuel economy.

Two groups of tests, A and B, were carried out. In group A, eleven series of bench studies were made on eleven different kinds of fuels. In group B, seven series of road tests were conducted. The bench studies were performed in the testing laboratory of the Department of Agricultural Engineering, College of Agriculture, University of the Philippines, and the road tests were run on one of the provincial highways bordering the College of Agriculture. The experiments were made from September, 1934 to January, 1935.

APPARATUS

The engine[2] used has the following specifications:

Model, 40.
Cylinder arrangement, 90° V, 90° crankshaft.
Firing order, 1-5-4-8-6-3-7-2.
Cylinder head, aluminum.
Piston displacement, 221″.
Taxable horsepower, 30.
Maximum brake horsepower, 90 at 3800 r.p.m.
Maximum torque, 147 ft. lbs. at 1250 r.p.m.
Compression ratio, 6.3 to 1.
Standard compression pressure—
    138 lbs. at 1600 r.p.m.
    At cranking speed, 105 lbs.
Number of cylinders, eight.
Valve arrangement, "L" head.
Bore, 3-1/16″; Stroke, 3-3/4″.
Engine mounted on—Rubber front and rear.
Number of points of suspension, three.

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[1] Experiment Station contribution No. 1055.
[2] The engine used is a Ford V-8, 1934.

A Fordor Sedan de Luxe loaded with five persons was used in the road tests. A Heenan & Froude (Worcester, England) hydraulic absorption dynamometer of a size D.P. × 4 was used to measure the brake horsepower. For weighing the fuel in the bench studies, there was employed a No. 4644-AP Bench scale, manufactured by the Toledo Scale Company of Toledo, Ohio. A Zenith mileage tester was used to measure the volume of fuel consumed during the road tests.

A description of the different fuels used is given in table 1.

Two grades of alcohol were required to form mixtures that would not separate at the operating temperatures during the tests. The lowest room temperature recorded during the tests was 22°C. (71.6°F.). Denatured alcohol, 193°[3] proof, was used in the mixtures containing 10 to 50 per cent alcohol. From 50 per cent up, a grade containing only 190° proof alcohol was utilized. The denaturant for the higher grade of alcohol was reported to be sulfuric ether and for the lower grade, gasoline. The lower grade is commercially known as Alkohl motor fuel.

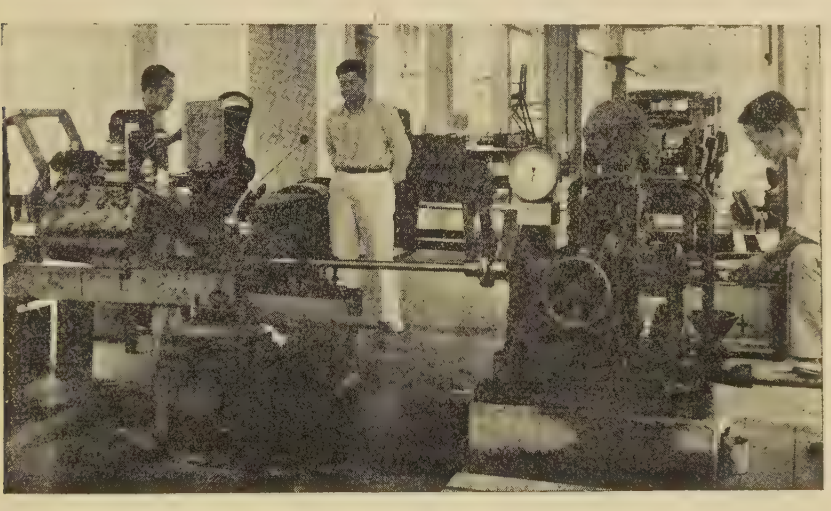

Fig. 1.—Showing a 1934 Ford V-8 being tested in a section of the Agricultural Engineering testing laboratory. Note the absorption hydraulic dynamometer used.

PROCEDURE

The bench test included the determination at different speeds of: (1) maximum horsepower; and (2) fuel economy at maximum, at ¾, at ½, and at ¼ maximum horsepower at each of the speeds. The maximum torque was determined during the maximum horsepower run at different speeds. For runs at ¾, ½, and ¼ maximum horsepower at the same speeds, the torque was set at ¾, ½, and ¼ the maximum. Proper throttling was made to accomplish the changes in loads.

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[3] U. S. proof.

The road test was made on an asphalt road covering a total distance of about 32 kilometers (approximately 20 miles). The average speed was 45 kilometers (28 miles) an hour. The gross weight of the car and of the occupants was about 1.6 metric tons.

Numerous trial tests were conducted on the bench at full throttle to determine at the highest possible engine speed the adjustment of the carburetion and of the ignition systems that would give maximum fuel economy at maximum brake horsepower. An adjustment that could maintain constant operation under this condition for at least three minutes was considered good. A modified cooling system as shown in figure 1 was used to regulate the temperature of the jacket water.

RESULTS AND DISCUSSION

The results of all road tests are shown in tables 2 to 8 and in charts 1 to 16.

Repeated trials showed that the engine could not run smoothly for over three minutes at engine speeds much above 2250 r.p.m., at full throttle. The torque curve had a gradual decrease after a minute's run and then dropped sharply afterwards. The length of time in which the operation could be maintained constant beyond 2250 r.p.m. was lengthened as the percentage of alcohol in the mixture was increased. The use of slightly larger jet to obtain a richer mixture also aided in increasing the time of maintaining constant operation at higher speeds. In all of the tests the maximum speed used was about 2200 r.p.m.

Gasoline. Gasoline was the first fuel tested. Four sets of carburetor jets were tried to represent adjustments that would give the most powerful, and most economical operations. The maximum brake horsepower developed with the most powerful adjustment was only about 2.5 per cent higher than the highest that could be developed with the economical adjustment. The fuel detonated very distinctly after a minute of operation on full throttle, especially at lower speeds. A proportionately greater amount of water cooling was needed to minimize detonation in leaner adjustments than in richer ones. As was expected, the fuel consumption using power jets were larger than in using economical jets. Considering the average fuel consumption with the most powerful adjustment as 100 per cent, the relative values were 97 per cent for the powerful adjustment, 94 per cent for the economical, and only 89 per cent for the most economical. Note that the engine operation was shaky at times with the use of the most economical jets. It is doubted if the engine could maintain very satisfactory operation with this jet if subjected to long usage. The engine pick-up was rather gradual.

A study of chart 1 shows the following:

a. Maximum brake m.e.p. = 95.4 lb./sq. in. at about 1600 r.p.m.
b. Maximum torque = 139.8 lb.–ft. at 1600 r.p.m.
c. Maximum brake thermal efficiency = 22.6 per cent at 3/4 load and 1400 r.p.m.
d. Most economical consumption = 0.557 lb./b.h.p.–hour at 3/4 load and 1400 r.p.m.

These data were based upon the most economical setting.

Mixture A—(*90 parts by vol. of gasoline + 10 parts by vol. of denatured 193° proof alcohol*). Regular tests with mixture A were conducted with the same adjustments as found in gasoline tests. Engine operation was as good, if not better, than gasoline especially at lower speeds. Detonation was greatly lessened, although not entirely eliminated, at the lowest possible running speeds on full throttle. The operation was smoother and the engine could maintain constant operation a longer time than it could with gasoline as fuel.

The following are shown in chart 2:

a. Maximum brake m.e.p. = 95.8 lb./sq. in. at 2200 r.p.m.
b. Maximum torque = 140.3 lb.–ft. at 2200 r.p.m.
c. Maximum brake thermal efficiency = 22.90 per cent at 3/4 load and 1550 r.p.m.
d. Most economical consumption = 0.573 lb./b.h.p.–hr. at 3/4 load and 1550 r.p.m.

Engine pick-up was fair.

Trial tests using powerful jet and economical jet with this mixture also showed that the consumption was less the smaller the jet used. Considering the consumption for a power jet as 100 per cent, the relative value for economical jet was from 97 to 98 per cent and for the most economical about 89 per cent.

Mixture B—(*80 parts by vol. of gasoline + 20 parts by vol. of denatured 193° proof alcohol*). Short trial tests on mixture B showed that a very slight decrease in maximum power was found when the adjustment used was the same as that of gasoline. Owing

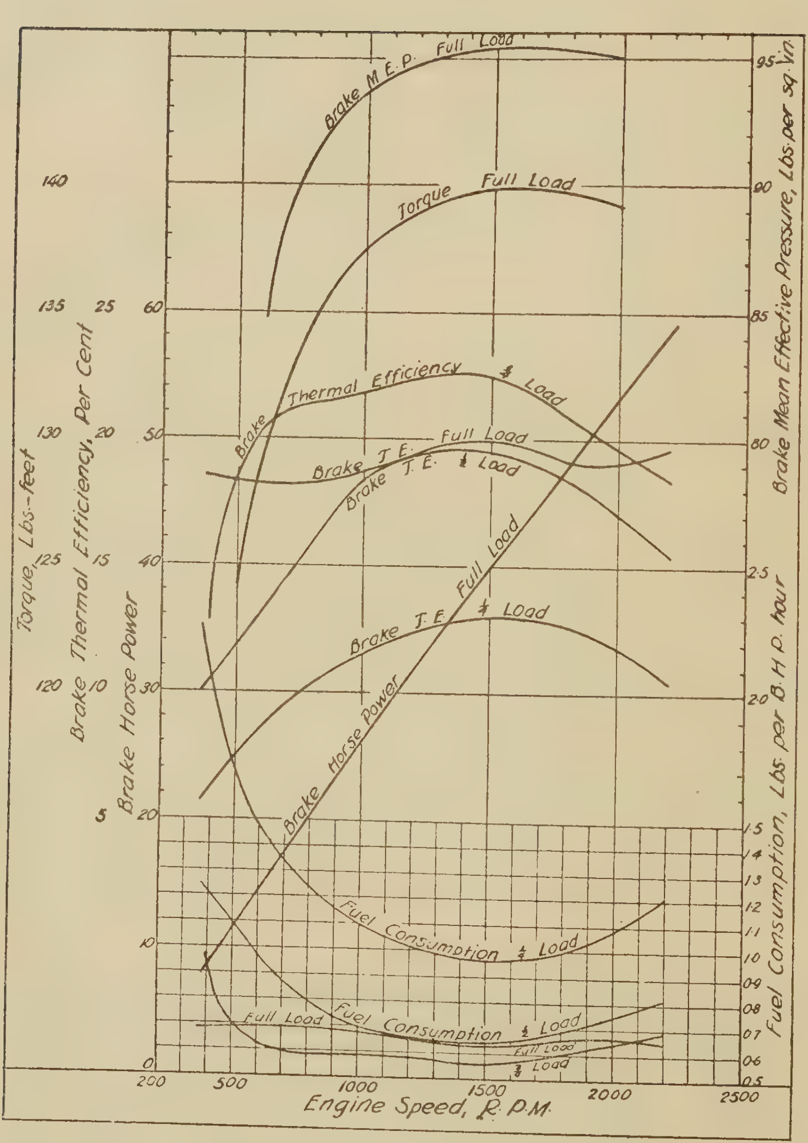

Chart 1—Performance curves of Ford V-8 using gasoline.

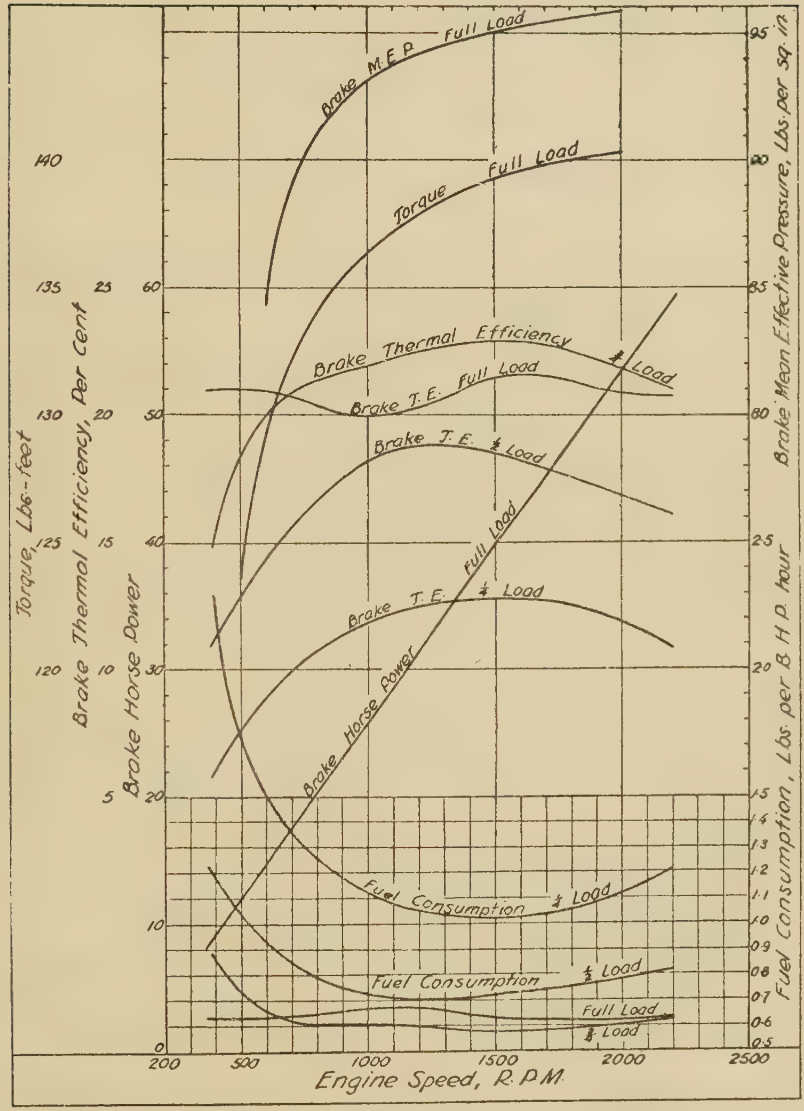

Chart 2—Performance curves of Ford V-8 using mixture A, 90 parts gasoline + 10 parts denatured 193° proof alcohol. Mixture by volume. Denaturant used—5 per cent sulfuric ether.

to this performance no attempt was made to use a larger jet. The engine showed a little sign of sluggishness in acceleration. Fuel knock was not noted.

Chart 3 indicates the following:

a. Maximum brake m.e.p. = 95 lb./sq. in. at 2200 r.p.m.
b. Maximum torque = 139 lb.-ft. at 2200 r.p.m.
c. Maximum brake thermal efficiency = 23.7 per cent at full load and 1400 r.p.m.
d. Most economical consumption = 0.581 lb./b.h.p.–hr. at full load and 1400 r.p.m.

Note that the most economical consumption was at full load and not at three-fourths loads, as was indicated in both gasoline and mixture A fuel economy curves.

Mixture C—(70 parts by vol. of gasoline + 30 parts by vol. of denatured 193° proof alcohol). Trial tests with this mixture showed that with the same adjustment as in gasoline the power that could be developed at full throttle was only about 83 per cent of the maximum for gasoline. The operation with wide open throttle was uniform only at about 1400 r.p.m. on half load. With the use of a larger jet or by partly choking the carburetor the power delivered was considerably increased and the operation became constant. Regular tests were run with power jets and not with the most economical size.

The maximum brake horsepower developed was more than 4 per cent higher than the maximum for gasoline. Hence, it is believed that the fuel consumption recorded was slightly higher than what it would have been had the maximum power been the same as with gasoline.

The following are indicated in chart 4:

a. Maximum brake m.e.p. = 99.2 lb./sq. in. at 2200 r.p.m.
b. Maximum torque = 145.3 lb.-ft. at 2200 r.p.m.
c. Maximum brake thermal efficiency = 22.4 per cent at three-fourths load and 1400 r.p.m.
d. Most economical consumption = 0.644 lb./b.h.p.-hr. at three-fourths load and 1400 r.p.m.

Engine operation was uniform and constant throughout each test. There was no evidence of fuel knock.

Mixture D—(60 parts by volume of gasoline + 40 parts by volume of 193° proof denatured alcohol). Regular tests with this mixture were made with engine adjustment similar to that used in mixture C. The power developed was high, being about 2.3 per cent

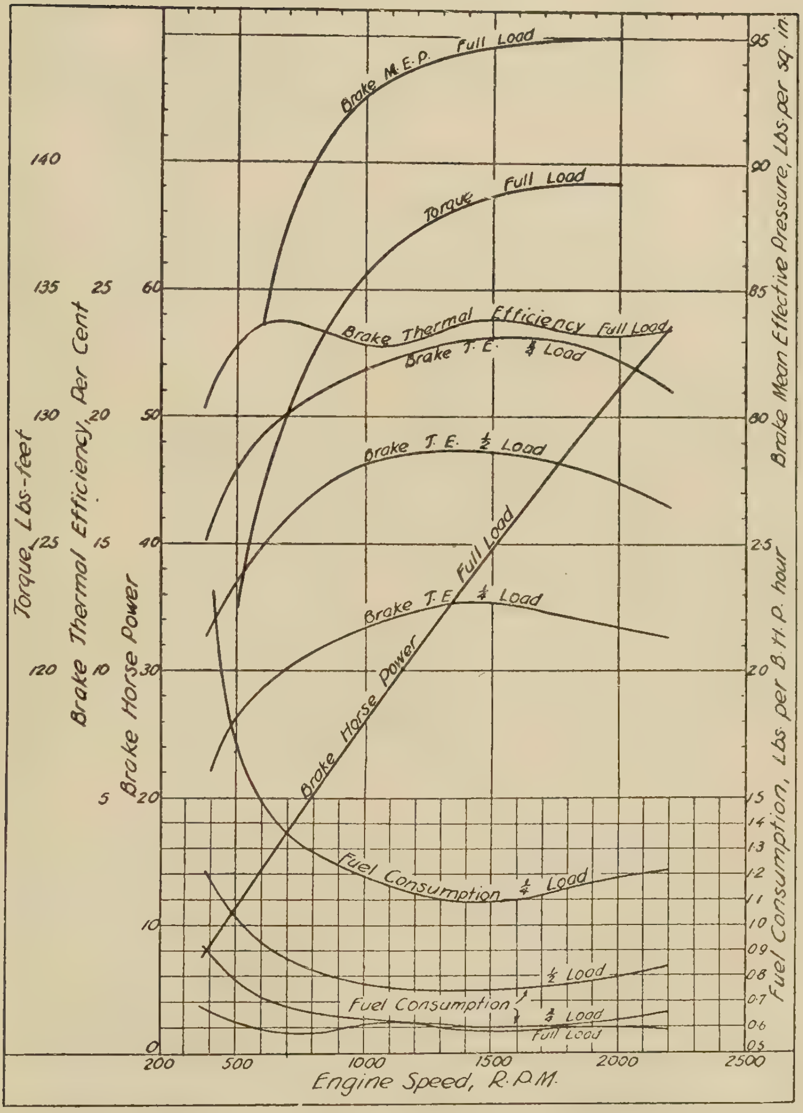

Chart 3—Performance curves of Ford V-8 using mixture B, 80 parts gasoline + 20 parts denatured 193° proof alcohol. Mixture by volume. Denaturant used—5 per cent sulfuric ether.

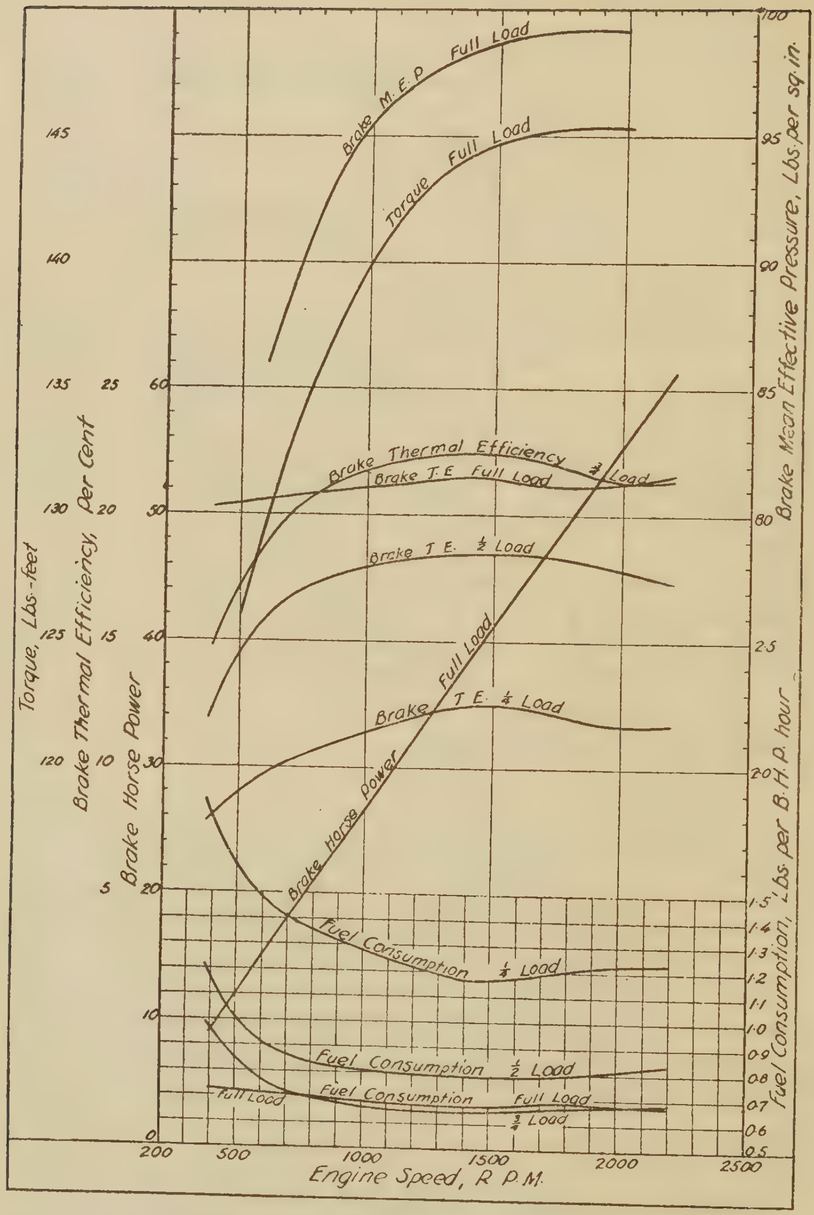

Chart 4—Performance curves of Ford V-8 using mixture C, 70 parts gasoline + 30 parts denatured 193° proof alcohol. Mixture by volume. Denaturant used—5 per cent sulfuric ether.

higher than the maximum for gasoline. The engine operated uniformly with no evidence of detonation.

The following are indicated in chart 5:

a. Maximum brake m.e.p. = 98.2 lb./sq. in. at 1600 r.p.m.
b. Maximum torque = 144 lb.-ft. at 1600 r.p.m.
c. Maximum brake thermal efficiency = 22.43 per cent at three-fourths load and 1400 r.p.m.
d. Most economical consumption = 0.675 lb./b.h.p.-hr. at three-fourths and 1400 r.p.m.

Note that with mixture D, the fuel consumption curve at three-fourths load was, in general, more economical than at full load. This result was similar to those obtained with gasoline and with mixtures A and B.

Mixture E—(50 parts by vol. of gasoline + 50 parts by vol. of alcohol motor fuel No. 8). Short trial tests with this mixture showed that without partly choking the carburetor, the maximum power that could be developed was only about 97 per cent of the maximum for gasoline when the adjustment used was the same as in mixtures C and D. Regular tests were run with partly pulled choke. The maximum brake horsepower delivered under this condition was nearly 2 per cent higher than the maximum for gasoline. It was noted that the operation of the engine at speeds below 500 r.p.m. was a little shaky and that constancy in operation could not be maintained for more than six minutes at these speeds.

The following are indicated in chart 6:

a. Maximum brake m.e.p. = 97 lb./sq. in. at 2000 r.p.m.
b. Maximum torque = 142.8 lb.-ft. at 2000 r.p.m.
c. Maximum brake thermal efficiency = 22.8 per cent at three-fourths load and 1808 r.p.m.
d. Most economical consumption = 0.702 lb./b.h.p.-hr. at three-fourths load and 1808 r.p.m.

Note that the fuel economy curve at three-fourths load is a little lower than that at full load.

Mixture F—(40 parts by vol. of gasoline + 60 parts by vol. of alcohol motor fuel No. 8). Trial tests with this fuel using adjustments similar to mixtures C and D disclosed that only about 95 per cent of the maximum power that could be developed with gasoline, was delivered with wide open choke. Partly choking the carburetor easily increased the maximum by over three per cent. No runs were made with larger jets. The engine operation was very satisfactory and showed no signs of unsteadiness except at 500 r.p.m. and below.

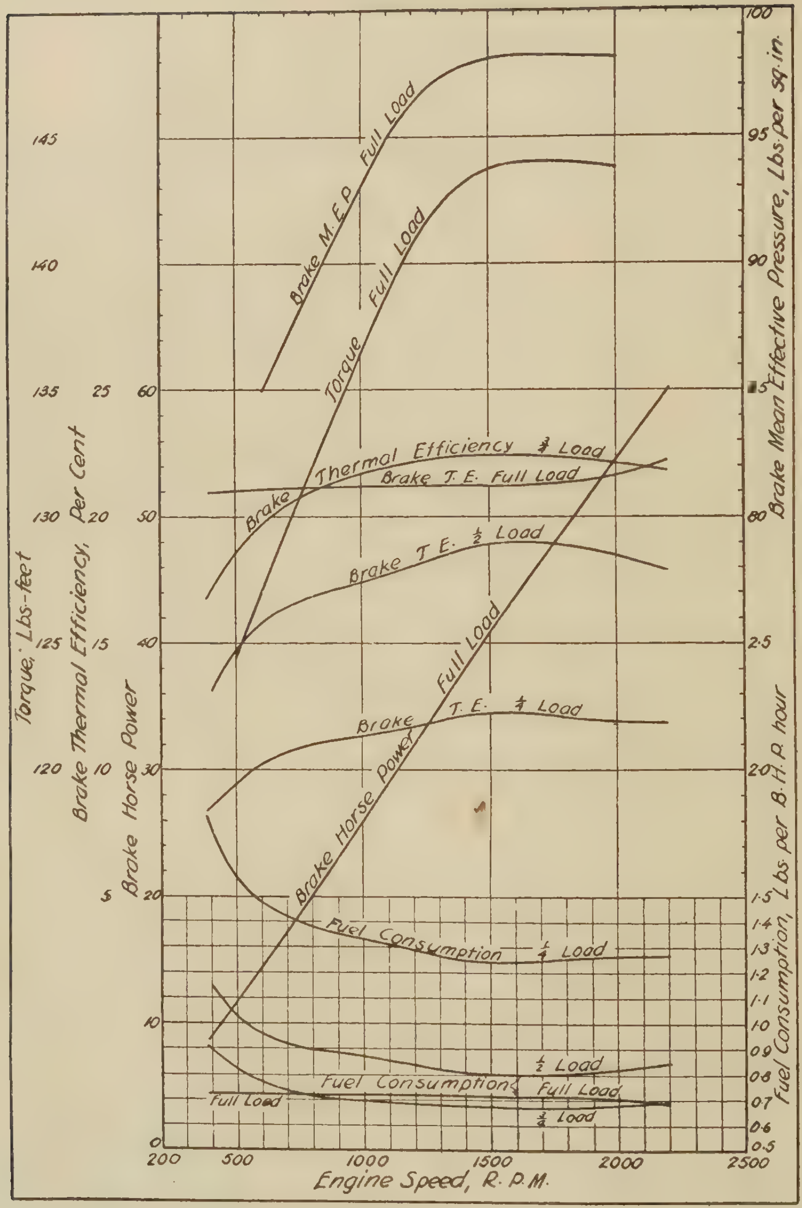

Chart 5—Performance curves of Ford V-8 using mixture D, 60 parts gasoline + 40 parts denatured 193° proof alcohol. Mixture by volume. Denaturant used—5 per cent sulfuric ether.

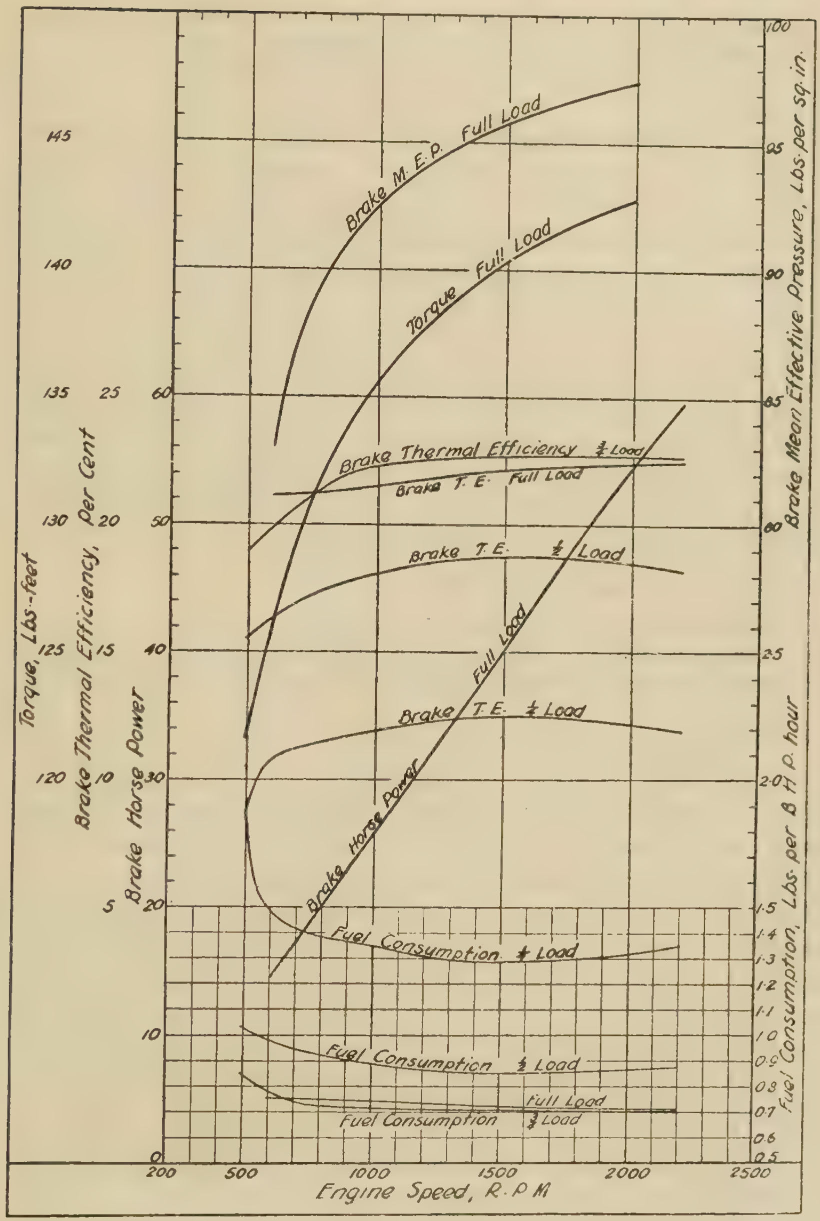

Chart 6—Performance curves of Ford V-8 using mixture E, 50 parts gasoline + 50 parts alcohol motor fuel No. 8. Mixture by volume. (Approx. 51.4% gasoline).

Chart 7 indicates the following:

a. Maximum brake m.e.p. = 98.2 lb./sq. in. at 1800 r.p.m.
b. Maximum torque = 144.2 lb.-ft. at 1850 r.p.m.
c. Maximum brake thermal efficiency = 22.67 per cent at full load and 1400 r.p.m.
d. Most economical consumption = 0.744 lb/b.h.p.-hr. at full load and 1400 r.p.m.

Note that the thermal efficiency curve at full load is below the curve of the three-fourths load from about 1550 r.p.m. to 2200 r.p.m. Below 1550 r.p.m. the curve for the full load is higher.

Mixture G—(30 parts by vol. of gasoline + 70 parts by vol. of alcohol motor fuel No. 8). The maximum power that could be developed using adjustments similar to mixtures C and D was only about 92 per cent of the maximum for gasoline. By partly choking the air valve, the power developed easily exceeded the maximum for gasoline. Regular tests were run with slightly pulled choke and not with larger jets. Below 500 r.p.m., the engine could not maintain constant operation for over six minutes.

The following are indicated in chart 8:

a. Maximum brake m.e.p. = 98.4 lb./sq. in. at 1900 r.p.m.
b. Maximum torque = 144.6 lb.-ft. at 1800 r.p.m.
c. Maximum brake thermal efficiency = 23.09 per cent at full load and 1800 r.p.m.
d. Most economical consumption = 0.773 lb./b.h.p.–hr. at full load and 1800 r.p.m.

The fuel consumption curve at full load definitely shows a more economical tendency at all speeds than at any other load.

Mixture H—(20 parts by vol. of gasoline + 80 parts by vol. of alcohol motor fuel No. 8). An entirely new set of power jets was used in this mixture for all regular tests. The maximum power developed was more than 5 per cent higher than the maximum for gasoline. No attempt was made to use a set of jets that would deliver a maximum power that was nearly the same as gasoline. It is believed that had economical jets been used, slightly lower consumption than what was recorded could be secured.

The following points are indicated in chart 9:

a. Maximum brake m.e.p. = 99.2 lb./sq. in. at 2200 r.p.m.
b. Maximum torque = 145.4 lb.–ft. at 2200 r.p.m.
c. Maximum brake thermal efficiency = 23.24 per cent at full load and 2200 r.p.m.
d. Most economical consumption = 0.816 lb./b.h.p.–hr. at full load and 2200 r.p.m.

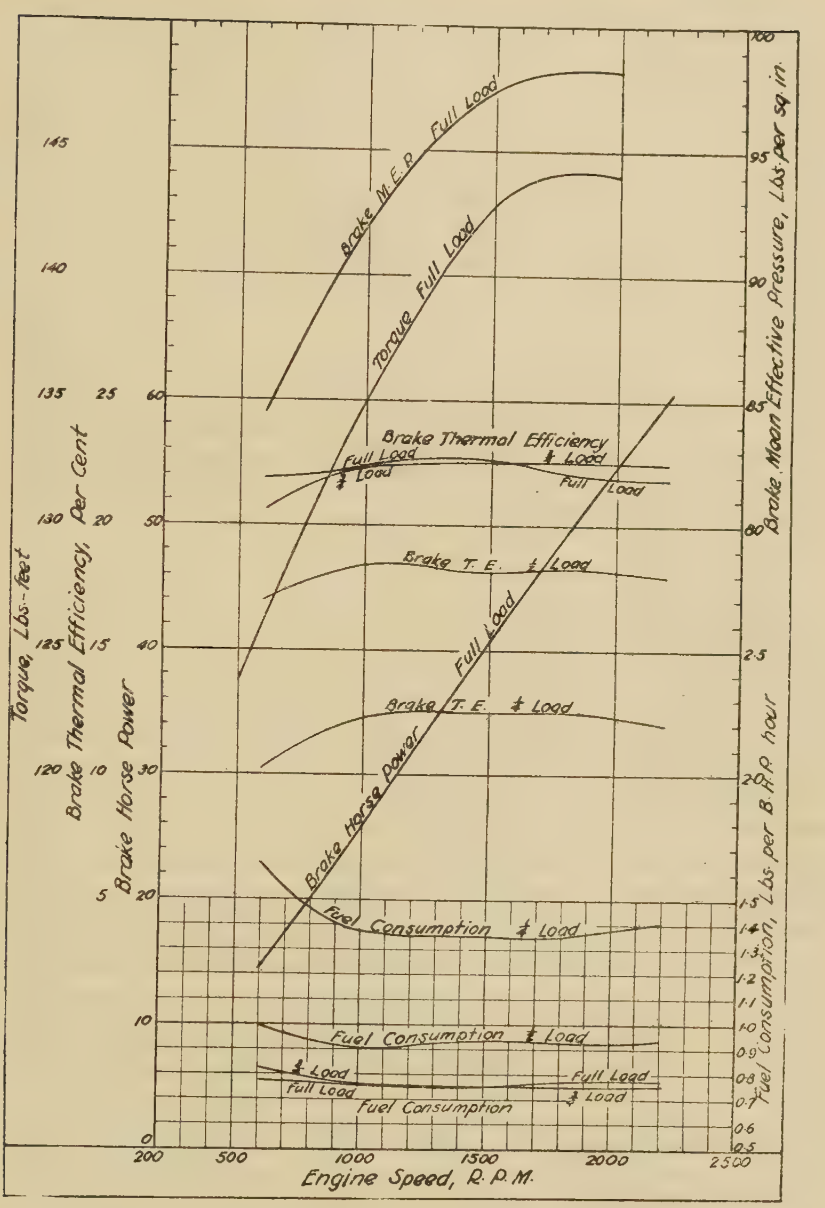

Chart 7—Performance curves of Ford V-8 using mixture F, 40 parts gasoline + 60 parts alcohol motor fuel No. 8. Mixture by volume. (Approx. 41.7% gasoline).

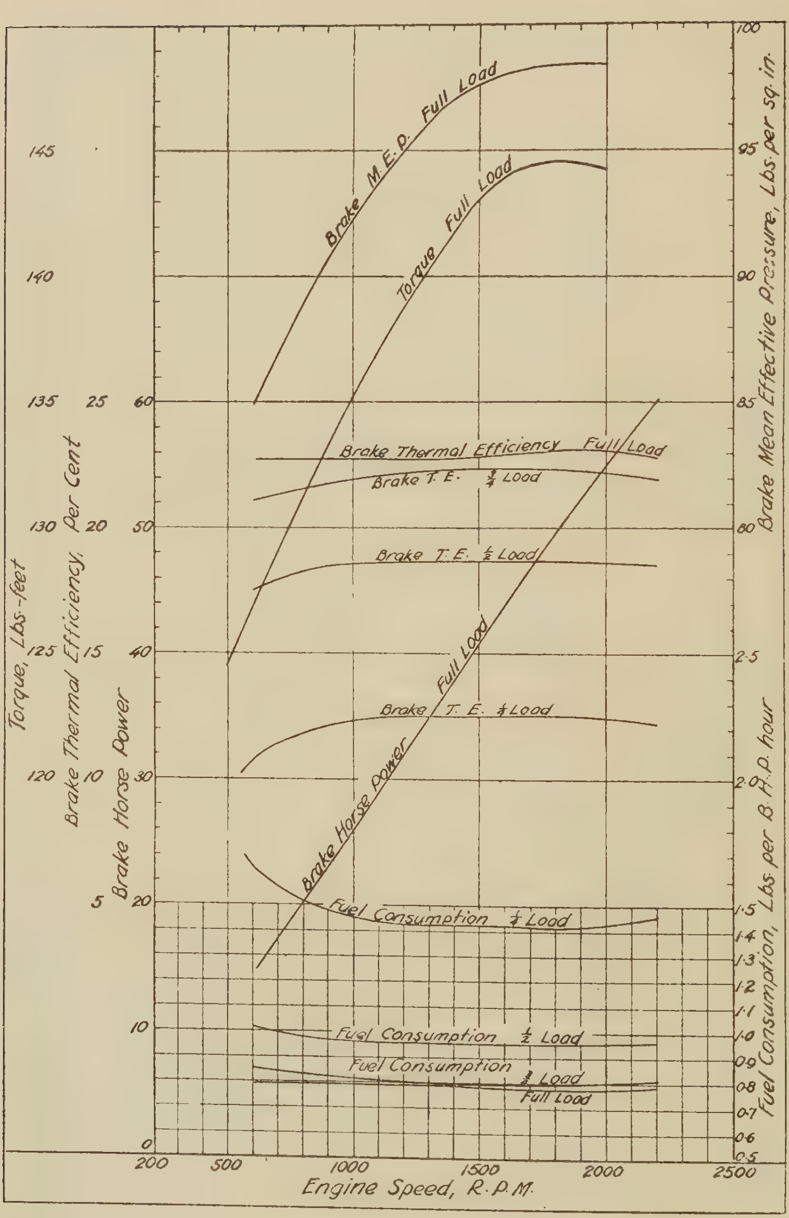

Chart 8—Performance curves of Ford V-8 using mixture G, 30 parts gasoline + 70 parts alcohol motor fuel No. 8. Mixture by volume. (Approx. 32.0% gasoline).

Engine operation was perfect except at speeds below 400 r.p.m. The fuel consumption at full load was the most economical.

Mixture I—(10 parts by vol. of gasoline + 90 parts by vol. of alcohol motor fuel No. 8). When an adjustment similar to the one used in mixture H was tried in this mixture, the maximum power delivered was about 1.5 per cent less than the maximum for gasoline. Choking the carburetor very slightly resulted in delivering a maximum power that was very nearly equal to that of gasoline. The engine operation was excellent except at speeds below 500 r.p.m. At these speeds constant running could not be maintained for over six minutes. Regular tests were run with partly choked air throttle and not with larger jets.

The following are shown in chart 10:

a. Maximum brake m.e.p. = 97.1 lb./sq. in. at 2200 r.p.m.
b. Maximum torque = 142.3 lb.–ft. at 2200 r.p.m.
c. Maximum brake thermal efficiency = 24.17 per cent at full load and 2200 r.p.m.
d. Most economical consumption = 0.837 lb./b.h.p.–hr. at full load and 2200 r.p.m.

The most economical consumption curve was at full load.

Mixture J—(Alcohol motor fuel No. 8—100 parts by vol. of 95 per cent ethyl alcohol + 3 parts by vol. of gasoline). Trial tests with this fuel using adjustment similar to mixture H showed a maximum power only about 97 per cent as high as the maximum for gasoline. Regular tests were run with partly choked air throttle. Approximately 5 per cent more power than the maximum for gasoline was obtained with the setting used. Engine operation was smooth at practically all loads except at points below 500 r.p.m. Further choking of the carburetor showed that the engine could deliver slightly greater maximum power than what was recorded in the test. It could maintain constant operation at this load without showing any sign of detonation or of hard laboring.

Chart 11 shows the following:

a. Maximum brake m.e.p. = 100.00 lb./sq. in. at 2200 r.p.m.
b. Maximum torque = 146.6 lb.–ft. at 2200 r.p.m.
c. Maximum brake thermal efficiency = 24.65 per cent at full load and 2200 r.p.m.
d. Most economical consumption = 0.880 lb./b.h.p.-hr. at full load and 2200 r.p.m.

The fuel consumption curve at full load was the most economical.

Power curves. A study of the performance curves in charts 1 to 11 definitely indicates that just as much power if not more could

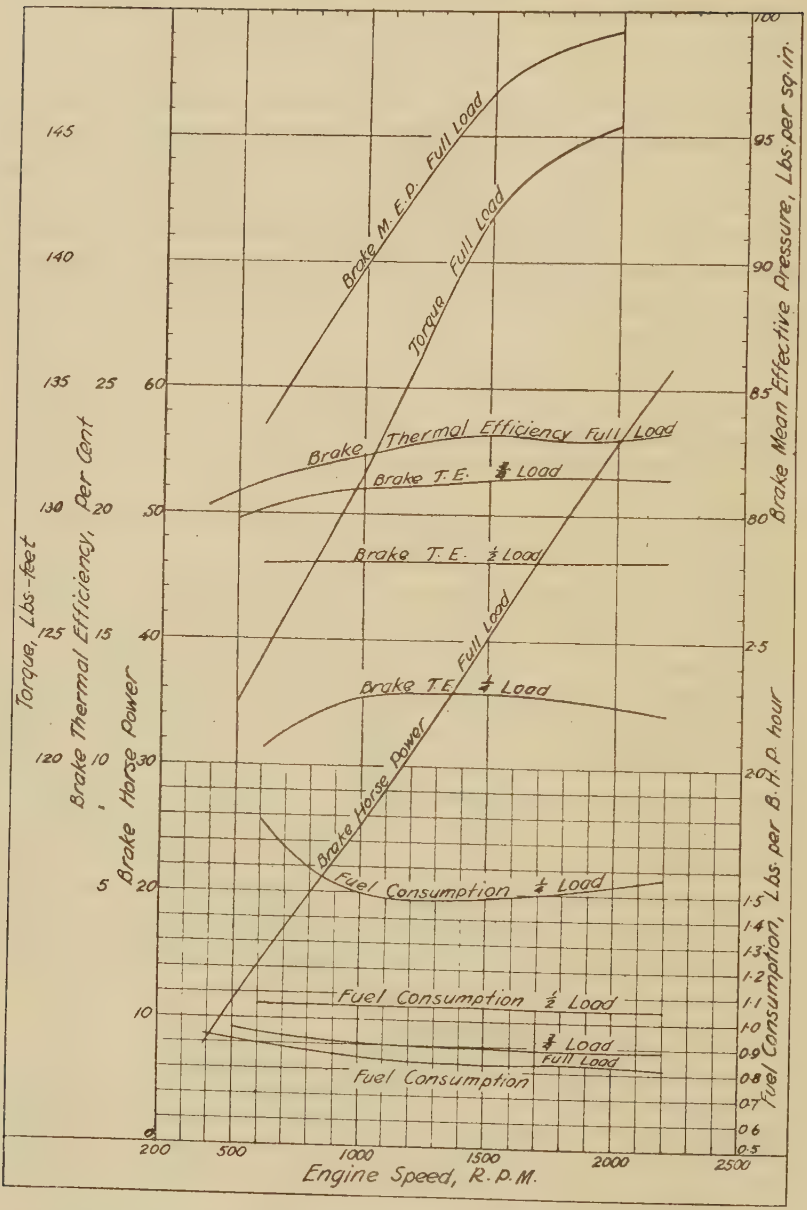

Chart 9—Performance curves of Ford V-8 using mixture H, 20 parts gasoline + 80 parts alcohol motor fuel No. 8. Mixture by volume. (Approx. 22.3% gasoline).

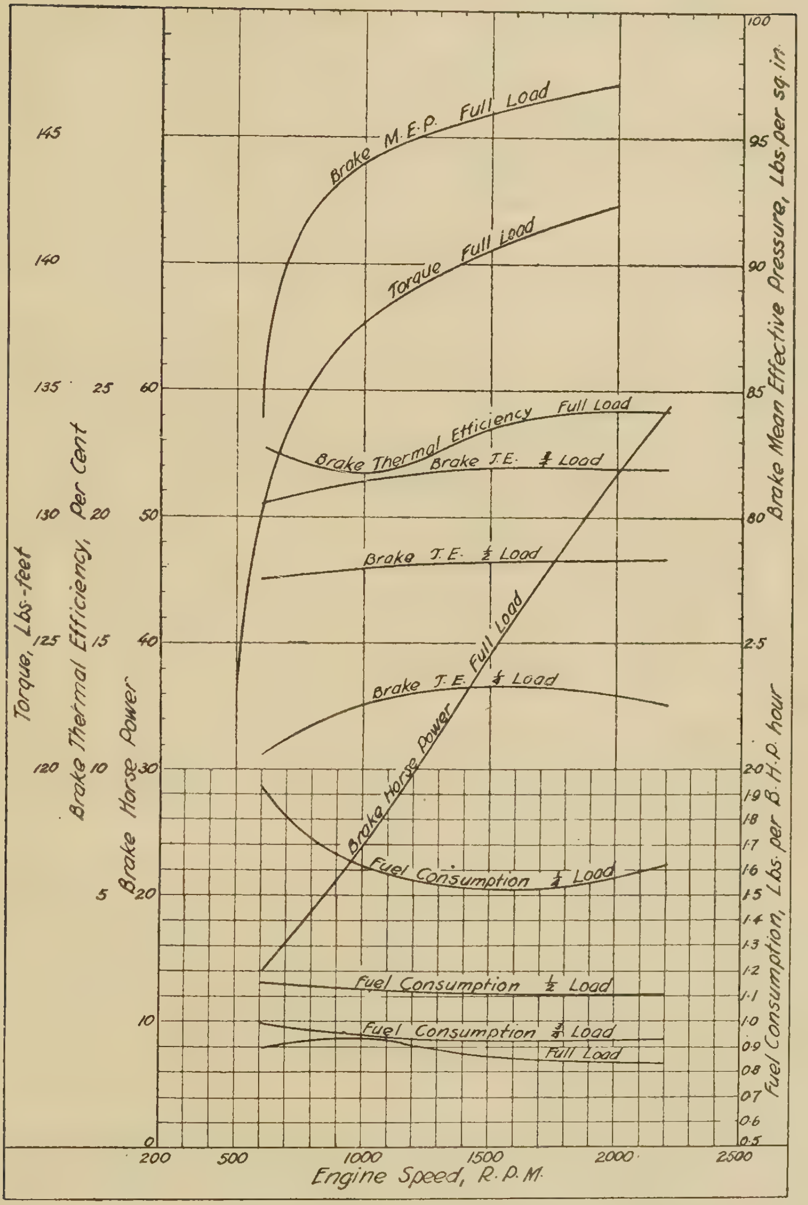

Chart 10—Performance curves of Ford V-8 using mixture I, 10 parts gasoline + 90 parts alcohol motor fuel No. 8. Mixture by volume. (Approx. 12.6% gasoline).

be developed with the use of alcohol and of alcohol-gasoline mixtures as with gasoline. Except in mixture B where tests were run with slightly less maximum power to obtain economical results, the power developed at 2000 r.p.m. on full throttle were higher than that of straight gasoline (see table 2). Practically the same characteristics were shown at 1500 r.p.m. An increase of 1.6 to 6 per cent was noted at 2000 r.p.m. and from 0.4 to 3.8 per cent at 1500 r.p.m. The maximum power developed at 1000 r.p.m. was higher in gasoline than in the mixtures except in C where there was an increase of 1.1 per cent. The rest showed a decrease of from 0.2 to 5 per cent. No definite relationship was found at 500 r.p.m.

Torque curves. A study of table 3 shows that the maximum torque at 2000 r.p.m. was in general, higher in each mixture than in straight gasoline. The maximum difference which was a little over 7 lb.-ft. was obtained when alcohol motor fuel was used alone. At 1500 r.p.m., mixtures A and B, exhibited a decrease of less than 1 per cent each, considering gasoline as the basis. A marked decrease in torque was exhibited at 1000 r.p.m. by nearly all the mixtures except C and I. The lowest decrease was registered in the case of alcohol motor fuel; it was about 4.8 per cent below that of gasoline. No fair comparisons could be made at 500 r.p.m. and below because of the unsteadiness of operation of the engine at these speeds.

The torque curves of mixtures A, B, E, I and J show nearly the same characteristics. In mixtures C, D, F, G, and H, the curves appear nearly straight up to 1000 to 1300 r.p.m. and flatten abruptly from these points to 2200 r.p.m.

Brake mean effective pressure. A study of table 4 definitely shows that, in general, the higher the speed the greater is the brake m.e.p. This is true in all mixtures. Owing to detonation, using gasoline, the brake m.e.p. was slightly higher at 1500 r.p.m. than at 2000 r.p.m. No definite relationship could be drawn between brake m.e.p. and percentage of alcohol in the mixture.

Fuel economy curves. A study of charts 12 to 16 and of tables 5 to 8 shows the following:

1. That at full load, the fuel consumption per b.h.p.-hour decreased as the percentage of alcohol in the mixture was increased up to 20. Below 1000 r.p.m., the decrease was about 8 per cent for every 10 per cent of alcohol added. Above 1000 r.p.m., only about 5 per cent decrease was found. Using gasoline, note that at speeds below 1000 r.p.m. the engine detonated very distinctly. Its operation using mixtures was almost free from pinking.

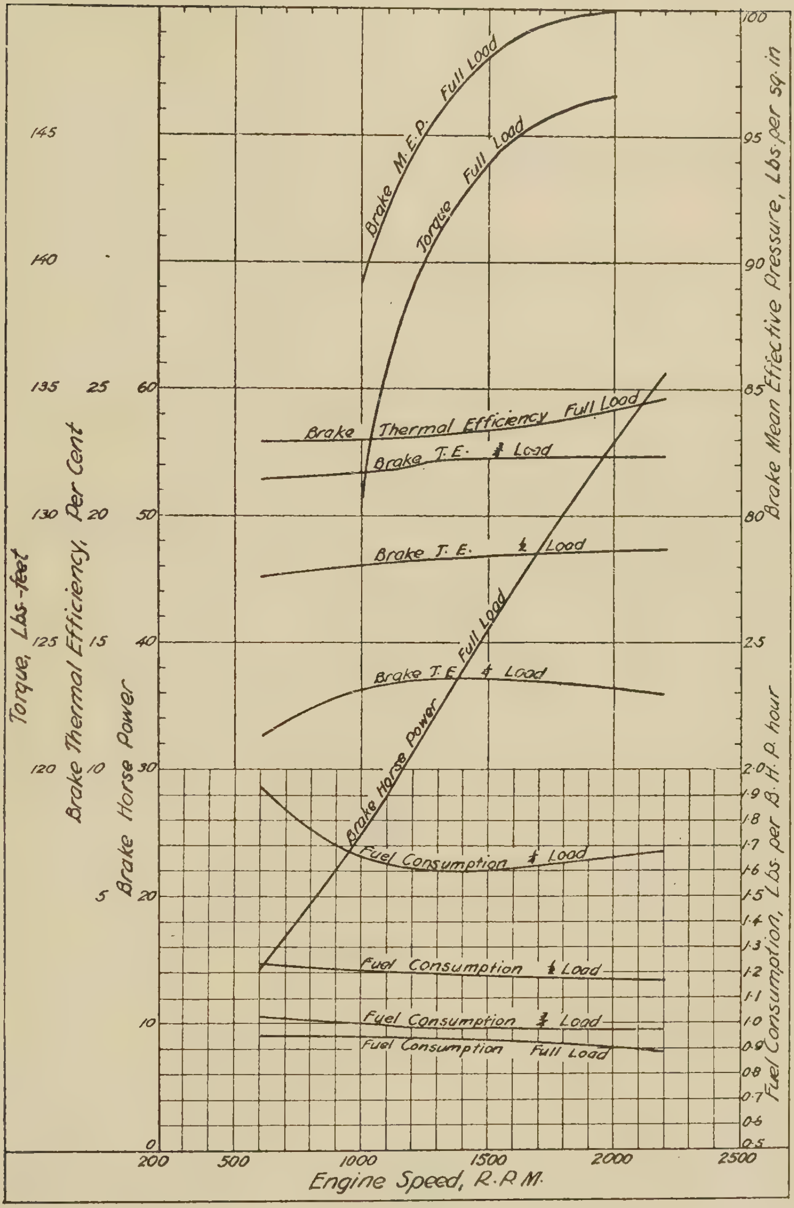

Chart 11—Performance curves of Ford V-8 using mixture J, 3 parts gasoline + 100 parts 95 per cent vol. ethyl alcohol. Mixture by volume. (Alcohol motor fuel No. 8.) (Approx. 2.9% gasoline.)

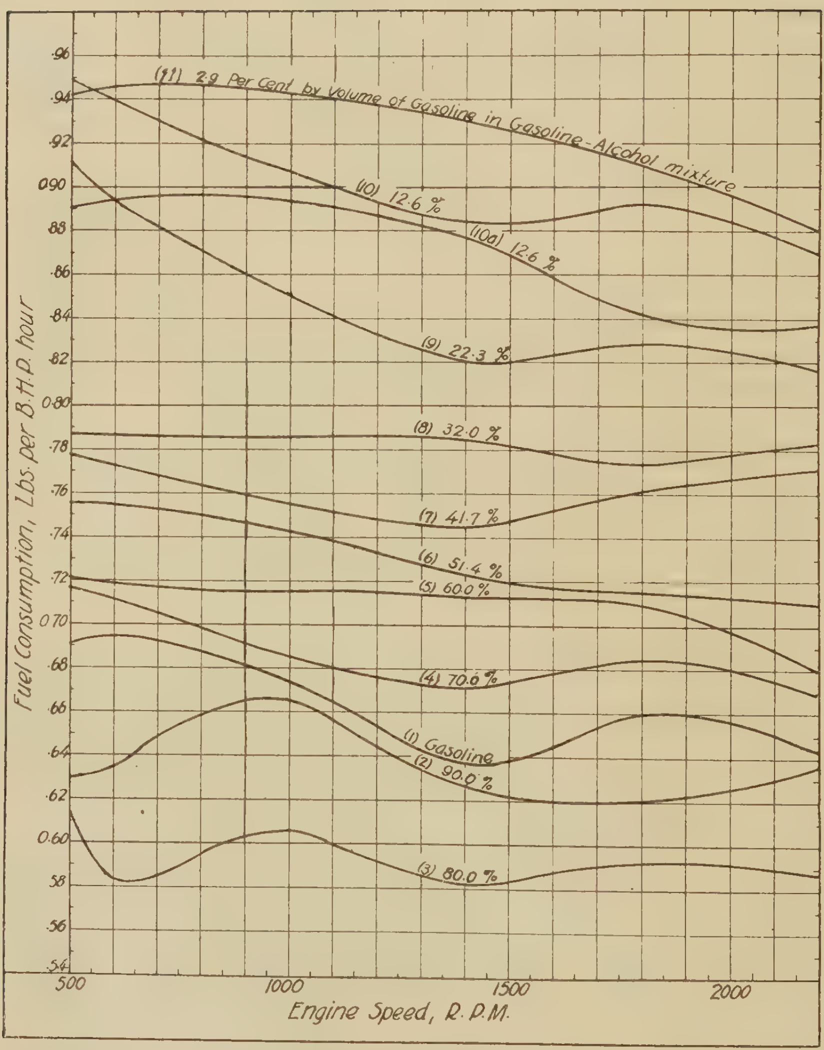

Chart 12—Showing the relation between fuel consumption and engine speed at full load using different fuels. Note:—Test 10A represents most economical adjustment.

That in mixtures C to J inclusive, an increase of about 6.5 per cent in fuel consumption was recorded for every 10 per cent increase of alcohol. The curves (see chart 16) indicate that a mixture containing 25 to 30 per cent alcohol would give approximately the same consumption as gasoline.

2. That at three-fourths load, gasoline was the most economical fuel at and below 1650 r.p.m. Above this point, mixture A was the most economical. At 2200 r.p.m., mixture C was more economical than gasoline.

That at 1500 r.p.m. and below, approximately 5 per cent increase was noted for every 10 per cent increase of alcohol up to the mixture containing 60 per cent gasoline (mixture D). Beyond this point the increase was larger, being as high as 16 per cent.

3. That at one-half load, gasoline was the most economical fuel. The consumption definitely increased as the amount of alcohol in the mixture was increased. Largest increases were noted at 1500 r.p.m. and smallest at 600 r.p.m.

4. That at one-fourth load, the consumption increased as the amount of alcohol in the mixture was increased. At 2000 r.p.m. the percentage increase per every 10 per cent of alcohol added varied from 3.5 to 4.3 in mixtures A to D, and from 4.1 to 8.6 in mixtures E to J. Increases of from 3.6 to 9.2 per cent were recorded in 1500 r.p.m.

It was noted during the tests that as the per cent of alcohol in the mixture was increased, sign of over-richness became more difficult to detect. It was easily possible to double the consumption of mixtures containing at least 70 per cent alcohol without marked change in the engine's performance and in the maximum power developed. Owing to this characteristic, varied results may be obtained when engines are tested on the road using alcohol.

Brake thermal efficiency curves. The following are shown in charts 12 to 16:

1. That at full load, mixture J has the highest efficiency at speeds varying from 850 to 1170 r.p.m. and from 1950 to 2200 r.p.m. Mixture I was highest from 1550 to 1950 r.p.m. and mixture B from 600 to 850 r.p.m. Except for mixtures B and F, it was indicated that the higher the percentage of alcohol in the mixture, the higher was the thermal efficiency. Gasoline had the lowest efficiency at all speeds. Mixture B exhibited a high efficiency probably because the carburetor was adjusted to give a maximum power that was not as high as the maximum power delivered by the other fuels. Mixture F indicated low efficiency from about 1750 r.p.m. to 2200 r.p.m.

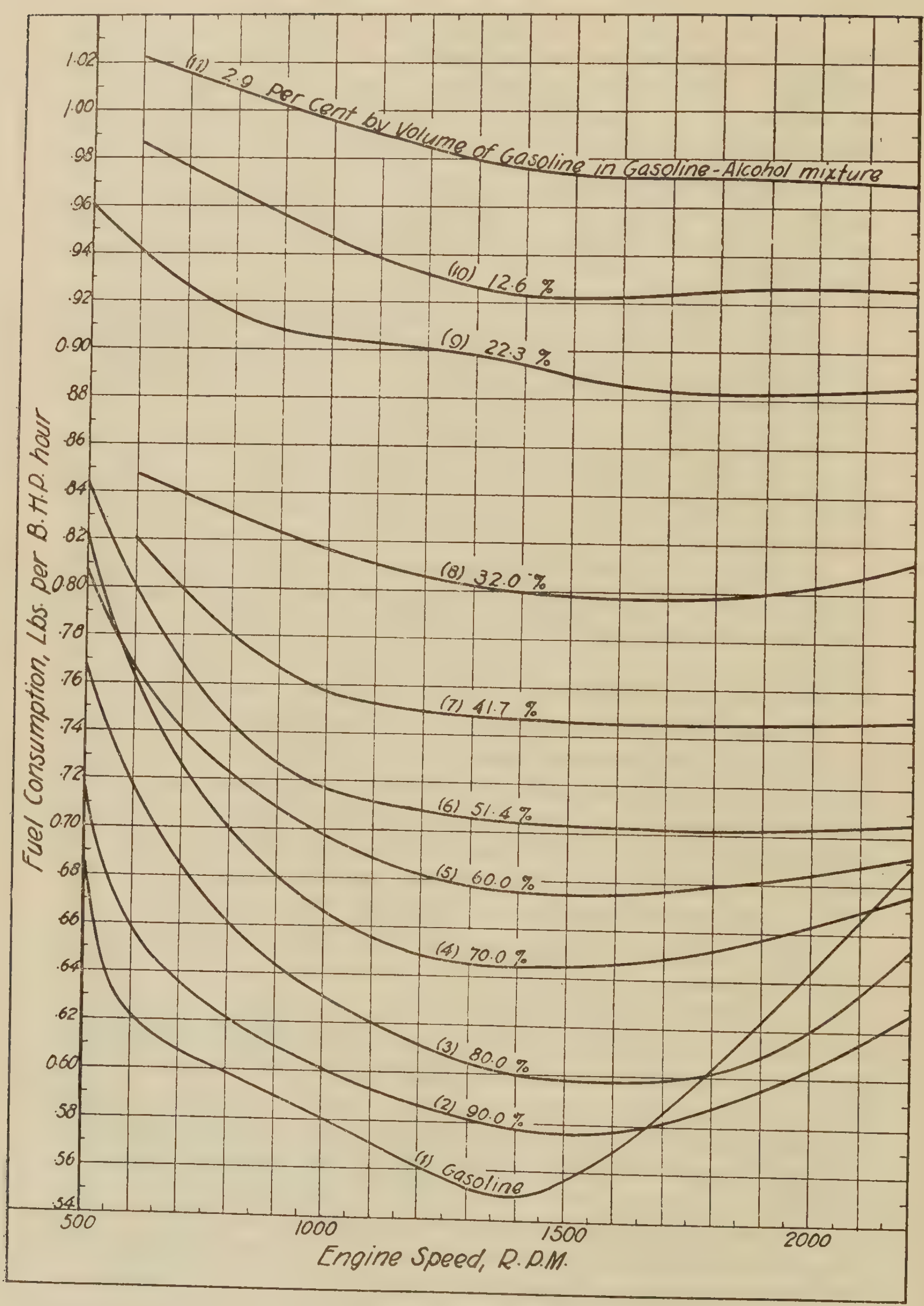

Chart 13—Showing the relation between fuel consumption and engine speed at three-fourths load using different fuels.

2. That at three-fourths load and 2200 r.p.m. mixtures, E, F, and J indicated the highest thermal efficiency, gasoline, the lowest, and mixture H showed lower efficiency than C or D. From 1400 to 1800 r.p.m., mixture B was highest. Mixture H indicated the lowest values from 800 to 1700 r.p.m. Gasoline had fairly high efficiency from 600 to about 1500 r.p.m. No definite relationship can be given between the percentage of alcohol in the mixture and of the brake thermal efficiency at three-fourths load.

3. That at one-half load, gasoline had the highest efficiency from about 1000 to 1400 r.p.m. At about 1400 r.p.m., all the mixtures containing 193° proof denatured alcohol indicated nearly the same efficiency. At speeds of 2200 and 600 r.p.m., the same mixtures showed that the higher the percentage of gasoline in the mixture the lower was the efficiency. Of the mixtures containing alcohol motor fuel No. 8, the highest efficiency was obtained in the blend containing the smallest amount of gasoline. Mixture H exhibited practically a straight line curve because the efficiencies at different speeds were nearly the same. Except from 1000 to about 1400 r.p.m. (where gasoline indicated high thermal efficiency) there was much evidence that the higher the percentage of alcohol in the mixture, the higher was the efficiency.

4. That at one-fourth load, the thermal efficiencies of the mixtures containing 193° proof denatured alcohol were higher as the percentage of alcohol in the mixture was increased at 600 and at 2200 r.p.m. From about 1300 to 1800 r.p.m., gasoline and mixture A showed higher efficiencies than the rest. The mixtures containing alcohol motor fuel No. 8 also showed that, in general, the higher the percentage of alcohol present the higher was the efficiency. Highest records at all speeds were obtained in the mixture containing the least amount of gasoline.

Road tests. Three series of tests were made on gasoline to determine the most economical adjustment. The average results obtained were as follows:

KIND OF JETS	MILEAGE		
	km./gal.	*mi./gal.*	*km./l.*
Power jet	26.75	16.62	7.07
Medium jet	27.10	16.84	7.16
Most economical jet	32.60	20.26	8.62

Note that the mileage with the use of the medium jet was 1.3 per cent higher than the average obtained with the power jet; with the most economical jet it was 21.8 per cent higher. Short trial tests with two sizes of intermediate jets showed mileages of about 17.5 and 18.5 miles per gallon. The most economical size was used for comparison because it was found by bench tests that a fairly high maximum power could be produced with this size. It must be noted, however, that engine starting with this adjustment was not always easy, and acceleration was not as quick as with the use of medium sizes.

Similar tests were carried out using a mixture containing 20 per cent 193° proof denatured alcohol. The results are as follows:

KIND OF JETS	MILEAGE		
	km./gal.	*mi./gal.*	*km./l.*
Power jet	28.70	17.83	7.58
Medium jet[4]	27.80	17.27	7.35
Most economical jet	31.85	19.79	8.42

Note that the mileage obtained using power jet with this mixture was more by about 7.3 per cent than what was obtained using the same jet with gasoline. A decrease of 2.3 per cent was made when the most economical jet was tested. The use of medium jet registered an increase of about 2.6 per cent over the average for gasoline in spite of the fact that when the mixture was tested the route was different, being hilly and covered with rough gravel.

The low average obtained with medium jet compared with power jet was mainly due to the dissimilarity of the road conditions. A difference of about 11 per cent was noted in the mileage between the use of power jet and of the most economical jet.

Another series of tests was carried out using the most economical jet on mixture A. An average mileage of 20.62 miles per gallon was made. Engine operation was the same as with gasoline and there was no evidence of detonation at any time during the test. The result definitely indicated that this mixture was better than gasoline under the conditions in which the tests were carried out.

The results of tests using the other mixtures are given as follows:

FUELS	MILEAGE			
	km./gal.	*mi./gal.*	*km./l.*	*per cent*
Gasoline	32.60	20.26	8.62	100.0
Mixture A	33.20	20.62	8.78	101.8
" B	31.85	19.79	8.42	97.7
" D	29.15	18.11	7.71	89.5
" F	25.05	15.56	6.62	76.8
" H	21.05	13.08	5.56	64.5
" J	18.95	11.77	5.01	58.1

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[4] Tests were conducted on a hilly route and not on the level as with other two jets.

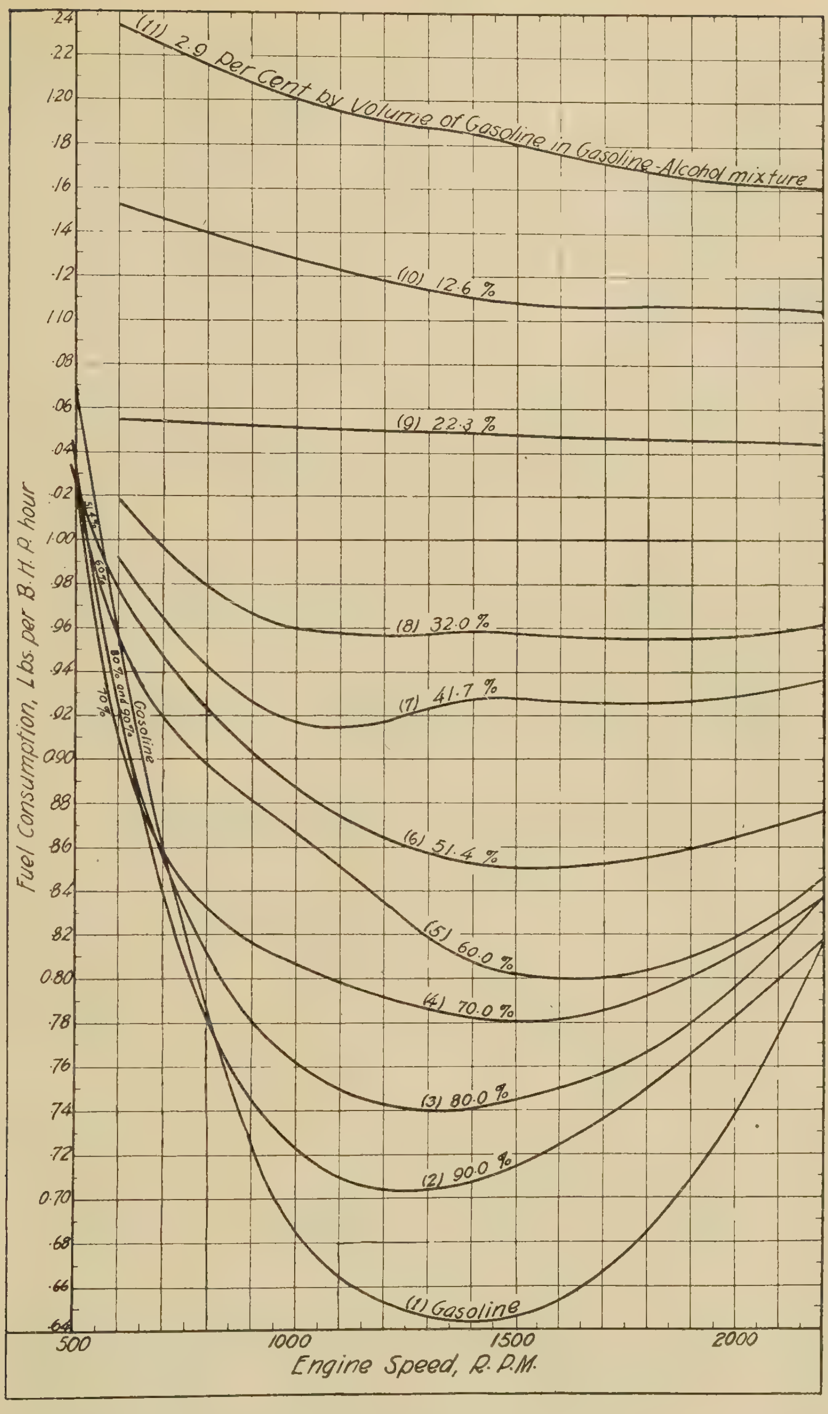

Chart 14—Showing the relation between fuel consumption and engine speed at one-half load using different fuels.

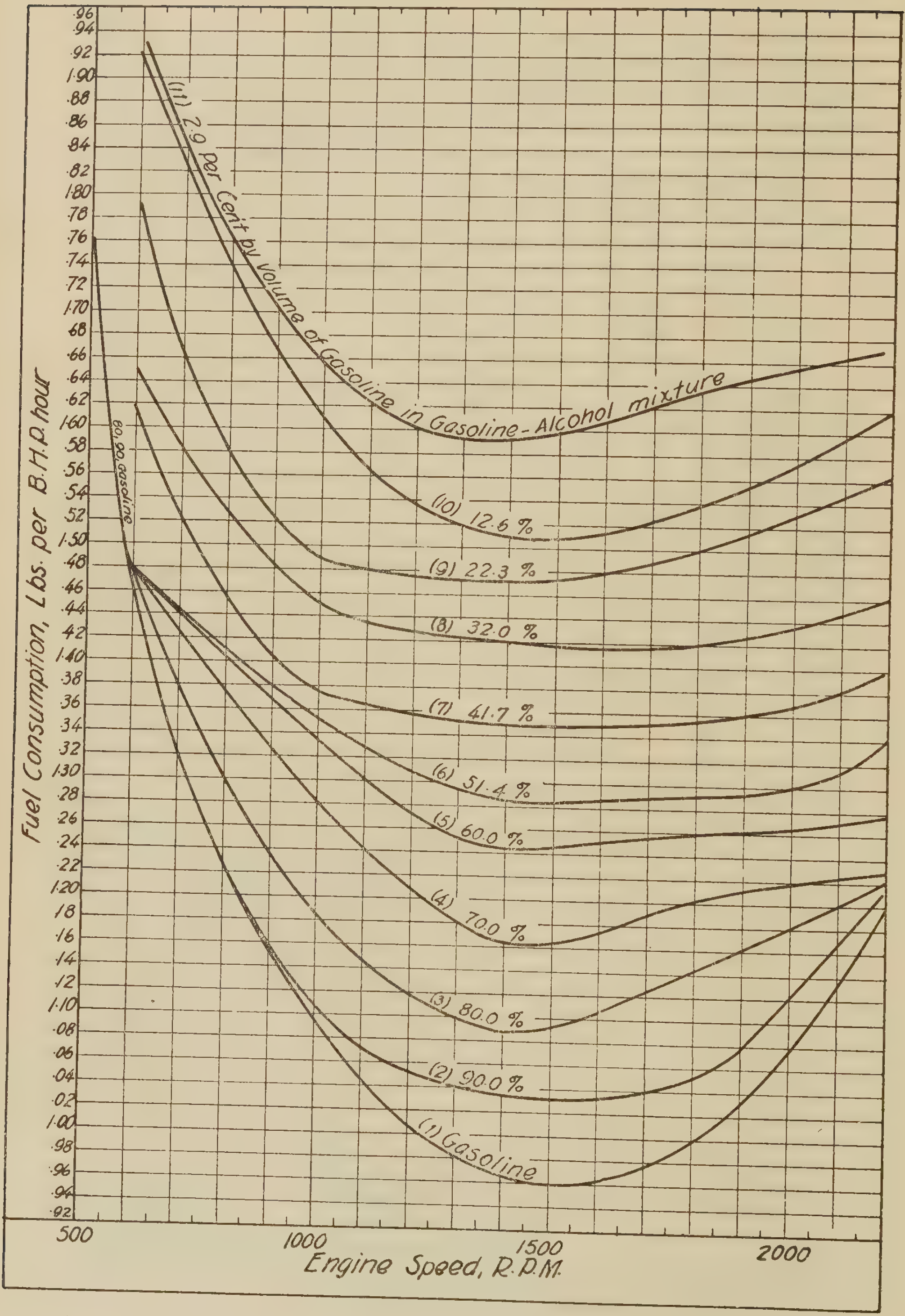

Chart 15—Showing the relation between fuel consumption and engine speed at one-fourth load using different fuels.

The mixture containing 10 per cent alcohol was the only blend that exceeded the mileage of gasoline.

Short trial tests with mixtures containing at least 40 per cent alcohol showed that it was easily possible to obtain adverse results in mileage by the use of wrong size of jets. Repeated tests with mixtures D and F demonstrated that without changing the size of jets, greater mileage could not be obtained with mixture D than with F. A very slight change, however, in the size of jets readily exhibited a definite increase amounting to over 10 per cent. Before any comparison is made between the performance characteristics of different fuels, especially those containing alcohol, the importance of a careful study of the carburetor adjustment best suited for each fuel cannot be over-emphasized. A difference of twenty per cent in the amount of alcohol added was not found sufficient in many cases to show evident changes in engine operation, particularly in road tests.

The results recorded above do not give a smooth curve if plotted, although the indication is that the larger the amount of alcohol present in the mixture the lower was the mileage. An attempt to find from over 100 experimental test data an empirical formula which will approximately give the mileage for any alcohol-gasoline combination using the Ford V-8, resulted in the following equation:[5]

$$y = 40e^{-0.00795x} - 7.74e^{-0.0816x}$$

where y = kilometers per gallon of fuel.

x = percentage of alcohol in the alcohol-gasoline combination.

The equation was determined following the type:

$$y = Ae^{bx} + Ce^{dx}$$

Using this equation the computed values for y are as follows:

x	*Computed value* y	*Assigned value* y	*Experimental value* y
0	32.3	32.8	32.6
10	33.5	33.1	33.2
20	32.9	32.3	31.9
30	30.9	30.8	——
40	28.8	29.0	29.1
50	27.1	27.1	——
60	25.0	25.0	25.0 [a]
70	23.0	23.1	——
80	21.2	21.2	21.1 [b]
90	19.5	19.4	——
100	18.0	17.8	18.9 [c]

[a] For mixture F; [b] for mixture H; [c] for mixture J.

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[5] Determined by E. M. Bautista of the Department of Agricultural Engineering, University of the Philippines.

The computed values above, given for gasoline and for mixtures A, B, D, F, H, and J, were very close to the experimental results.

Relation between computed calorific values and mileage. The results of tests show that to some extent the calorific value of the fuel is an indication of the mileage that the car may make under certain conditions. Without changing the size of the venturi tube or limiting the amount of air necessary for carburetion, calorific values will also indicate the size of jet necessary in the carburetor to attain satisfactory engine performance. Except in the mixtures containing as high as 15 per cent alcohol, where it was not found requisite to change the size of jet to produce enough high power with very satisfactory operation, the calorific value of the fuel exhibits a

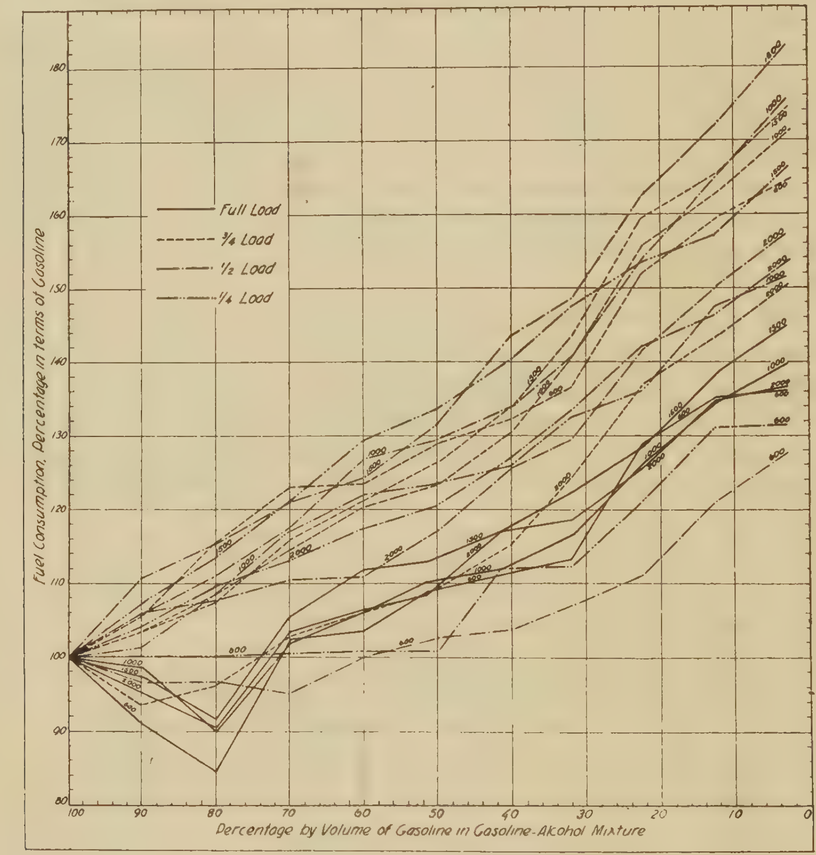

Chart 16—Showing the relation between the fuel consumption and the percentage by volume of gasoline in gasoline-alcohol mixtures. Consumption is expressed in percentage with gasoline as 100 per cent.

direct ratio with the mileage and an inverse ratio with the size of jet used. As shown in chart 17, the lower the calorific value, the less is the mileage and the larger is the size of jet used. (Exclude mixtures A and B.).

SUMMARY AND CONCLUSIONS

The results of this study point to the following facts:

1. That the engine of the Ford V-8 1934 showed a very satisfactory performance when alcohol, gasoline, and alcohol-gasoline combinations were used as fuels.

2. That a mixture containing 5 per cent 193° proof denatured alcohol was found miscible with gasoline as low as 21°C.

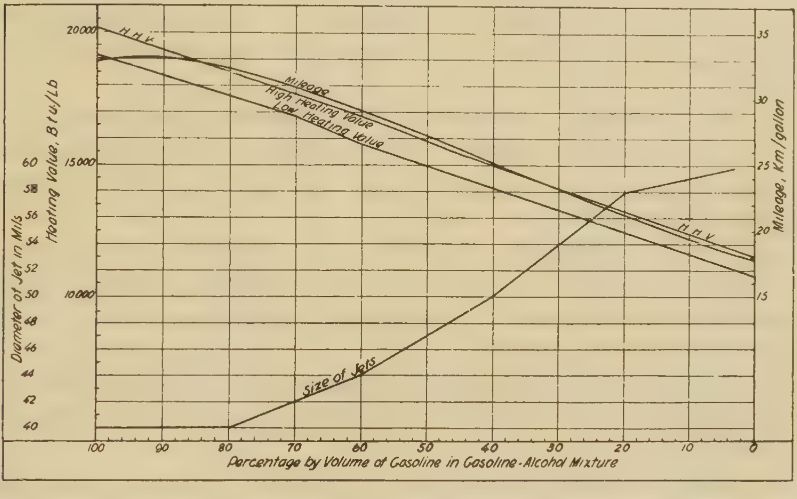

Chart 17—Showing the relation of the percentage by volume of gasoline in gasoline-alcohol mixtures to the jet diameter in mils, heating value of fuel, and mileage.

3. That the engine adjustment best suited for gasoline was found ideal for operation on mixtures containing as high as 15 per cent alcohol. To obtain a very satisfactory performance, a part choking of the carburetor was needed for mixtures containing 20 per cent alcohol.

4. To produce the same power as gasoline without changing the size of the venturi tube or of the air passage area, jets larger than the one adapted for gasoline were used for mixtures containing at least 15 per cent alcohol.

5. At speeds below 500 r.p.m., very economical adjustments with mixtures containing at least 20 per cent alcohol were often characterized by jerky and uneven operations.

6. Engine detonation was much in evidence using gasoline at full throttle. Pinking was minimized as the percentage of alcohol in the mixture was increased. No sign of detonation was noted at any load and speed when the mixture used contained at least 20 per cent alcohol.

7. In general, constancy in operation at higher loads could be maintained for a longer time with the mixtures than with gasoline.

8. If desired, greater maximum power could be developed with mixtures than with straight gasoline. This is true especially for mixtures containing a large amount of alcohol.

9. As the percentage of alcohol in the mixture was increased, the engine pick-up was slightly slowed down. Engine starting with almost straight alcohol was not always very easy when the engine was cold.

10. The following observations were indicated in general:

a. That at full load and at some points in three-fourths load, the mixtures containing as high as 20 per cent alcohol were more economical than gasoline.

b. That at other loads, the larger the percentage of alcohol in the mixtures the higher was the fuel consumption per b.h.p.-hour. The increases varied from an average of 4 to 6 per cent per every 10 per cent of alcohol added.

c. That the mixture containing the least amount of gasoline had the highest efficiency. At full load, gasoline had the lowest efficiency on all speeds.

11. That a mixture containing 10 per cent alcohol gave greater mileage than gasoline under the conditions in which they were tested.

TABLE 1

Different kinds of fuels used

FUEL	CALCULATED HIGH HEATING VALUES	CONSTITUENTS [a]
	B.T.U. per lb.	
Gasoline	20,150	Straight gasoline.
Mixture A	19,316	90 parts gasoline + 10 parts denatured 193° proof alcohol.[b]
" B	18,482	80 " " + 20 " " " " "
" C	17,647	70 " " + 30 " " " " "
" D	16,813	60 " " + 40 " " " " "
" E	15,942	50 " " + 50 parts alcohol motor fuel No. 8.[c] (Approx. 51.4% gasoline)
" F	15,101	40 " " + 60 " " " " " " (" 41.7% ")
" G	14,259	30 " " + 70 " " " " " " (" 32.0% ")
" H	13,418	20 " " + 80 " " " " " " (" 22.3% ")
" I	12,577	10 " " + 90 " " " " " " (" 12.6% ")
" J	11,735	3 " " + 100 parts 95 per cent vol. ethyl alcohol. (Approx. 2.9% gasoline) (Alcohol motor fuel No. 8)

[a] Mixtures by volume.

[b] Denaturant used—5 per cent sulfuric ether.

[c] Alcohol motor fuel No. 8—Contains 100 parts by volume of 95 per cent ethyl alcohol and 3 parts by volume of commercial gasoline.

TABLE 2

Maximum power at different engine r.p.m. Full throttle. Ford V-8—1934

PERCENTAGE OF GASOLINE IN BLEND	ENGINE SPEED IN R.P.M.							
	2000		1500		1000		500	
	b.h.p.	*per cent*	*b.h.p.*	*per cent*	*b.h.p.*	*per cent*	*b.h.p.*	*per cent*
100.0	52.9	100.0	39.8	100.0	26.3	100.0	11.5	100.0
90.0	53.7	101.6	39.8	100.0	26.1	99.2	11.7	101.8
80.0	52.1	98.5	39.6	99.5	26.1	99.2	11.6	100.8
70.0	55.6	105.2	41.4	103.8	26.6	101.1	11.9	103.3
60.0	54.3	102.6	40.8	102.5	26.0	98.8	11.8	102.5
51.4	54.7	103.5	40.2	101.0	25.9	98.5	11.4 [a]	99.2
41.7	54.9	103.8	40.8	102.5	26.0	98.8	11.5 [a]	100.0
32.0	54.8	103.7	40.8	102.5	26.0	98.8	11.5 [a]	100.0
22.3	55.8	105.2	40.2	101.0	25.3	96.2	11.4 [a]	99.2
12.6	54.4	102.7	40.0	100.4	26.3	100.0	11.7 [a]	101.8
2.9	56.1	106.0	41.1	103.0	25.0	95.0	12.1 [a]	105.1

[a] Calculated from curves.

TABLE 3

Torque at different engine r.p.m. Full throttle. Ford V-8 1934

PERCENTAGE OF GASOLINE IN BLEND	ENGINE SPEED IN R.P.M.							
	2000		1500		1000		500	
	lb.-ft.	*per cent*	*lb.-ft.*	*per cent*	*lb.-ft.*	*per cent*	*lb.-ft.*	*per cent*
100.0	139.2	100.0	139.8	100.0	137.4	100.0	124.2	100.0
90.0	140.4	100.9	139.2	99.6	136.4	99.4	123.6	99.5
80.0	139.2	100.0	138.7	99.2	135.7	98.7	122.5	98.6
70.0	145.3	104.4	144.7	103.3	139.9	101.8	126.0	101.3
60.0	143.8	103.2	143.8	102.7	136.5	99.5	124.4	100.2
51.4	142.8	102.5	140.4	100.4	135.7	98.7	121.6 [a]	97.8
41.7	144.0	103.5	142.8	102.0	134.9	98.3	123.7 [a]	99.5
32.0	144.2	103.7	143.1	102.3	135.3	98.6	124.5 [a]	100.2
22.3	145.4	104.8	141.9	101.4	131.7	95.8	122.4	98.6
12.6	142.3	102.3	140.5	100.4	137.7	100.1	123.0 [a]	99.0
2.9	146.6	105.2	144.0	103.0	130.7	95.2	—	—

[a] Calculated from curves. After three minutes running engine could not maintain constant operation at this speed.

TABLE 4

Computed brake-m.e.p., at different speeds on full throttle using different blends

PERCENTAGE OF GASOLINE IN MIXTURE	ENGINE SPEED IN R.P.M.							
	2000		1500		1000		600	
	lb./sq.in.	*per cent*	*lb./sq.in.*	*per cent*	*lb./sq.in.*	*per cent*	*lb./sq.in.*	*per cent*
100.0	95.0	100.0	95.4	100.0	93.7	100.0	84.7	100.0
90.0	95.8	100.8	95.0	99.7	93.1	99.3	84.3	99.7
80.0	95.0	100.0	94.6	99.2	92.6	98.8	83.6	98.7
70.0	99.1	104.3	98.7	103.5	95.5	101.7	86.0	101.5
60.0	98.1	103.3	98.1	102.8	93.1	99.4	84.9	100.3
51.4	97.4	102.6	95.8	100.4	92.6	98.8	83.0	98.0
41.7	98.2	103.4	97.4	102.1	92.0	98.3	84.4	99.7
32.0	98.4	103.6	97.6	102.4	92.3	98.5	84.9	100.3
22.3	99.2	104.4	96.8	101.5	89.9	94.5	83.5	98.6
12.6	97.1	102.2	95.9	100.5	94.0	100.2	83.9	98.1
2.9	100.0	105.3	98.2	102.9	89.2	95.2	—	—

TABLE 5

Fuel consumption at full load in the different blends at engine r.p.m. of 2000, 1500, 1000, and 600. Computed from curves plotted in charts 2 to 12

PERCENTAGE OF GASOLINE IN MIXTURE	ENGINE SPEED IN R.P.M.							
	2000		1500		1000		600	
	lb./b.h.p.-hr.	*per cent*	*lb./b.h.p.-hr.*	*per cent*	*lb./b.h.p.-hr.*	*per cent*	*lb./b.h.p.-hr.*	*per cent*
100.0	0.656	100.0	0.638	100.0	0.674	100.0	0.694	100.0
90.0	0.625	95.3	0.622	97.5	0.665	98.7	0.632	91.1
80.0	0.592	90.3	0.585	91.7	0.606	89.9	0.583	84.1
70.0	0.680	103.6	0.674	105.6	0.686	101.8	0.711	102.5
60.0	0.699	106.5	0.713	111.8	0.715	106.1	0.719	103.6
50.0	0.725	110.5	0.724	113.5	0.748	110.9	0.761	109.6
40.0	0.770	117.4	0.754	118.2	0.758	112.4	0.774	111.5
30.0	0.783	119.4	0.788	123.5	0.795	117.9	0.801	115.4
20.0	0.840	128.0	0.833	130.6	0.865	128.3	0.910	131.1
10.0	0.890	135.6	0.897	140.6	0.918	136.1	0.943	135.9
2.9	0.896	136.5	0.925	145.0	0.943	139.9	0.945	136.2

TABLE 6

Fuel consumption at three-fourths load in the different blends at engine r.p.m. of 2000, 1500, 1000, and 600. Computed from curves plotted in charts 2 to 12

PERCENTAGE OF GASOLINE IN MIXTURE	ENGINE SPEED IN R.P.M.							
	2000		1500		1000		600	
	lb./b.h.p.-hr.	*per cent*	*lb./b.h.p.-hr.*	*per cent*	*lb./b.h.p.-hr.*	*per cent*	*lb./b.h.p.-hr.*	*per cent*
100.0	0.645	100.0	0.557	100.0	0.581	100.0	0.620	100.0
90.0	0.604	93.7	0.576	103.4	0.601	103.5	0.656	105.8
80.0	0.620	96.1	0.598	107.3	0.631	108.6	0.716	115.5
70.0	0.663	102.8	0.645	115.8	0.666	114.6	0.762	122.9
60.0	0.684	106.0	0.675	121.1	0.698	120.2	0.766	123.6
50.0	0.703	109.0	0.703	126.2	0.716	123.2	0.799	128.9
40.0	0.746	115.6	0.746	133.9	0.758	130.5	0.820	132.2
32.0	0.802	124.4	0.798	143.2	0.816	140.4	0.847	136.6
22.3	0.883	136.9	0.889	159.6	0.905	155.8	0.941	151.8
12.6	0.926	143.5	0.922	165.6	0.946	162.8	0.987	159.2
2.9	0.971	150.5	0.974	174.8	0.995	171.3	1.022	164.9

TABLE 7

Fuel consumption at one-half load in the different blends at engine r.p.m. of 2000, 1500, 1000, and 600. Computed from curves plotted in charts 2 to 12

PERCENTAGE OF GASOLINE IN MIXTURE	ENGINE SPEED IN R.P.M.							
	2000		1500		1000		600	
	lb./b.h.p.-hr.	*per cent*	*lb./b.h.p.-hr.*	*per cent*	*lb./b.h.p.-hr.*	*per cent*	*lb./b.h.p.-hr.*	*per cent*
100.0	0.738	100.0	0.645	100.0	0.684	100.0	0.955	100.0
90.0	0.782	105.9	0.715	110.8	0.723	105.7	0.921	96.5
80.0	0.795	107.7	0.744	115.4	0.760	111.1	0.921	96.5
70.0	0.815	110.4	0.780	120.9	0.805	117.7	0.908	95.1
60.0	0.818	110.8	0.801	124.2	0.867	126.8	0.955	100.0
50.0	0.864	117.0	0.850	131.7	0.886	129.5	0.977	102.3
40.0	0.928	125.7	0.927	143.7	0.916	133.9	0.991	103.8
32.0	0.956	129.5	0.957	148.4	0.960	140.4	1.016	106.9
22.3	1.044	141.3	1.048	162.6	1.051	153.7	1.055	111.0
12.6	1.107	150.0	1.108	171.9	1.128	165.0	1.151	121.1
2.9	1.163	157.5	1.180	183.0	1.201	175.7	1.232	129.7

TABLE 8

Fuel consumption at one-fourth load in the different blends at engine r.p.m. of 2000, 1500, 1000, and 600. Computed from curves plotted in charts 2 to 12

PERCENTAGE IN GASOLINE IN MIXTURE	ENGINE SPEED IN R.P.M.							
	2000		1500		1000		600	
	lb./b.h.p.-hr.	*per cent*	*lb./b.h.p.-hr.*	*per cent*	*lb./b.h.p.-hr.*	*per cent*	*lb./b.h.p.-hr.*	*per cent*
100.0	1.077	100.0	0.960	100.0	1.093	100.0	1.467	100.0
90.0	1.120	104.0	1.032	107.4	1.108	101.4	1.468	100.1
80.0	1.180	109.6	1.090	113.5	1.187	108.6	1.467	100.0
70.0	1.218	113.1	1.163	121.1	1.280	117.1	1.476	100.6
60.0	1.264	117.4	1.245	129.6	1.333	121.9	1.479	100.8
50.0	1.300	120.7	1.283	133.6	1.351	123.6	1.479	100.8
40.0	1.368	127.0	1.349	140.5	1.376	125.9	1.643	112.0
32.0	1.437	133.4	1.415	147.3	1.448	132.5	1.646	112.2
22.3	1.530	142.0	1.474	153.5	1.488	136.1	1.777	121.1
12.6	1.573	146.1	1.509	157.1	1.610	147.3	1.923	131.1
2.9	1.655	153.7	1.598	166.3	1.656	151.5	1.932	131.7

CHEMICAL ANALYSIS OF BLOOD OF FIVE MALE AND FIVE FEMALE CARABAOS[1]

ELIAS G. POSA

In view of the encouraging biochemical interest that a government institution, besides the College of Agriculture, is taking in the native carabao (*Bubalus bubalis* L.) it seems worth while to report some results of blood analysis made in the College of Agriculture from October 1931 to February 1933.

Ten native carabaos were used in the work; a brief history of each follows:

Animal I, male, black, entire, about four and a half years old, owned by the College of Veterinary Science, pastured at time of tests in the grounds of that college in Los Baños, progeny of animal IV. Received three injections of *Mycobacterium tuberculosis* (Bovine strain) but showed no indication of infection when examined both clinically and by laboratory methods.

Animal II, male, black, castrated, about eight years old, owned by Mr. Valentin Babadilla, Raymundo Barrio; pastured in the open.

Animal III, female, albino, open, about two and a half years old, owned by the College of Veterinary Science, pastured in the grounds of that college at Los Baños, progeny of animal IV. Received two injections of *Mycobacterium tuberculosis* (Bovine strain) with results similar to that reported for animal I.

Animal IV, female, black, pregnant, about ten years old, owned by the College of Veterinary Science and pastured in the premises of that college. Received four injections of *Mycobacterium tuberculosis* (Bovine strain) and one injection of Avian strain but showed no indication of tuberculosis infection when examined clinically and by laboratory methods.

Animal V, male, black, castrated, about fourteen years old, owned by Mr. Apolinario Maligalig; pastured in the open in the Raymundo Barrio, Los Baños.

Animal VI, female, black, open, about fifteen years old, owned by Mr. Emilio Revilleza residing in Coconut Grove; pastured and fed by ordinary methods.

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[1] The data in this paper were taken from a thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 462; Experiment Station contribution No. 1056. Prepared in the Department of Agricultural Chemistry under the direction of Dr. F. O. Santos.

Animal VIII, female, black, open, about fifteen years old, owned by Mr. Emilio Revilleza; pastured in the open.

Animal VIII, female, black, pregnant, from five to six years old, owned by Mr. Valentin Manipol residing in Raymundo Barrio, Los Baños; pastured in the open.

Animal IX, male, black, entire, about one and one half years old, owned by Aling Rosa, residing in the Raymundo Barrio; pastured in the open.

Animal X, male, black, entire, about one and a half years old; owned by Aling Rosa.

The blood cell counts and haemoglobin determinations of the animals used in these studies when compared with the determinations made by Boynton (1912) on twenty-five supposedly normal carabaos were found to be similar, as may be seen in the following tabulation: the similarity indicates that they were normal:

Showing blood counts of the animals studied[a]

	RED	WHITE	HAEMOGLOBIN
			per cent
Animal I	5,670,000	8,000	90
Animal II	8,020,000	8,760	90
Animal III	5,990,000	8,000	90
Animal IV	8,000,000	12,000	95
Animal V	5,490,000	8,700	85
Animal VI	5,889,000	9,000	85
Animal VII	6,890,000	10,000	95
Animal VIII	7,860,000	8,340	85
Animal IX	5,890,000	8,960	80
Animal X	5,698,000	9,500	95
Average	6,539,700	9,126	89
Maximum	8,020,000	12,000	95
Minimum	5,490,000	8,000	80

The results of the examinations of the blood of twenty-five supposedly normal carabaos (Boynton, 1912):

	RED	WHITE	HAEMOGLOBIN
			per cent
Average	6,057,520	10,389	92.6
Maximum	7,000,000	18,500	100.0
Minimum	5,228,000	6,000	85.0

[a] Determined by the Department of Bacteriology and Pathology, College of Veterinary Science, University of the Philippines.

All the animals were fed and used for work as usual during the period of this study.

Each carabao was bled at least twice, with an interval of one week between.

Bleeding of the animals was done in the Large Animal Clinic of the College of Veterinary Science under the direction of Doctors Angel K. Gomez and Jose B. Uichanco of that college. The samples were obtained from the jugular vein by using a sterile hypodermic needle connected with a piece of rubber tubing; thus the flow of blood could be controlled. The blood was allowed to flow into a graduated cylinder. When the necessary amount of blood was obtained, the flow was stopped and the blood poured into a large test tube containing a weighed quantity of potassium oxalate which prevented the blood from coagulating. Twenty-mgm. of potassium oxalate for every 10 ml. of blood were used for this purpose. The contents of the tube were gently shaken. The sample was then taken to the Biochemical Laboratory where it was prepared for the different analyses.

For calcium determination, a separate sample of 5 ml. was also obtained.

The methods of analysis used were essentially those of Folin and Wu. (Hawk, 1923).

For total nitrogen the ordinary Kjeldahl method was used and one ml. of whole blood was taken for each determination. For non-protein nitrogen the suggestions of Leiboff (1929), particularly as to overcoming bumping during digestion with the use of sand bath and a flat bottomed 50 ml. Pyrex volumetric flask, were followed. For uric acid, Benedict's (Hawk, 1923) method was used. The method of Marriott and Howland (Underhill, 1921) was used for calcium determination.

RESULTS

The results are given in table 1 and are compared with the analysis of blood of other kinds of animals, as found by other investigators. The figures are averages of at least 4 determinations. The calcium content of the serum of the carabaos studied is more than twice the calcium of the serum of other animals.

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TABLE 1

Showing analysis of blood of ten carabaos compared with analysis of blood of other kinds of animals

SUBJECTS		Total nitrogen	MILLIGRAMS PER 100 ML. OF BLOOD							
Animal No.	Sex		Non-protein nitrogen	Urea	Uric acid	Creatinine	Creatine	Chlorides as NaCl	Serum calcium	Sugar
		mgm. per ml.								
I	Male	30.26	30.86	14.88	1.47	1.61	3.93	438.07	26.72	83.65
II	Male	30.60	26.34	13.42	1.88	1.47	4.64	482.78	28.26	86.19
III	Female	26.50	32.11	12.94	1.58	1.75	4.98	427.24	26.84	60.48
IV	Female	28.10	28.04	12.51	1.44	1.56	3.83	509.02	26.26	56.55
V	Male	28.99	27.94	12.18	1.14	1.61	4.36	509.06	27.66	56.77
VI	Female	31.11	28.18	12.68	1.08	2.14	3.33	530.15	28.31	62.92
VII	Female	30.92	31.46	15.65	1.13	2.14	3.76	465.21	27.07	70.37
VIII	Female	33.03	27.71	13.97	2.00	1.40	4.55	474.04	33.44	89.40
IX	Male	32.06	27.08	12.96	2.12	1.56	5.66	467.69	29.44	86.94
X	Male	28.82	25.79	13.90	1.94	1.56	5.24	469.71	27.88	83.22
Average (Male)		30.15	27.61	13.47	1.71	1.56	4.77	473.46	27.99	79.35
Average (Female)		29.93	29.50	13.51	1.45	1.80	4.09	481.13	28.38	67.94
Average (Male and Female)		30.04	28.55	13.51	1.57	1.68	4.43	477.29	28.19	73.65
Maximum		33.03	32.11	15.65	2.12	2.14	5.66	530.15	33.44	89.40
Minimum		26.50	25.79	12.18	1.08	1.40	3.33	427.24	26.57	56.55
Horses	(Kintner and Holt, 1932)		28.7	14.2	2.81	1.80		451	11.2	92
Horses	(Hayden and Tubangui, 1919-20)		33.9	17.8	2.45	1.80				127.5
Cattle	(” ” ” ”)		30.6	17.65	2.14	1.82				95.6
Swine	(” ” ” ”)		35.07	19.4	2.06	1.42				87.1
Sheep	(” ” ” ”)		31.5	17.8		1.26				115
Horses	(Holt and Reynolds, 1924)		25.82	14.81	2.76	1.4				109
Cow	(Hayden and Fish, 1928)		29.79	12.21	2.04	1.20		444.1	10.88	46.52
Dog	(” ” ” ”)		30.8	11.7		1.5		468		82
Chicken	(” ” ” ”)		28.82	5.39	2.47	1.10		487.6	9.9	139.1
Male goat	” ” ” ” (Normal)		32.22	14.99	little	1.17		484.99	10.32	59.11
Male goat	” ” ” (Castrated)		32.57	14.97	little	1.12		491.76	10.9	56.69

A STUDY OF THE EFFECTS UPON GROWTH AND DEVELOPMENT OF AN UPLAND RICE OF VARYING THE MOISTURE CONTENT OF SOIL IN POTS[1]

GUILLERMO O. PALIS

WITH FOUR FIGURES

The original plan of this study was to determine the "water requirement" of an upland rice using the term in the sense as used by Briggs and Shantz (1913), and at the same time to improve upon the method employed by these investigators by controlling the moisture content of the soil in pots. By weekly addition of water to the pots to replace what had been lost, it was found to be possible to maintain a fairly constant moisture content of the soil, but escape of moisture directly from the pots could not be prevented. For this reason, the study was conducted primarily to determine the effects upon the growth and development of an upland rice of varying the moisture content of clay-loam soil in pots. The term "water requirement" of the rice plant is used in this report to indicate the ratio of the amount of water that was lost by transpiration from the leaves and by direct evaporation through an opening at the mouth of each pot to the weight of the dry matter produced. Owing to the limited time at the disposal of the writer, most of the experiments were closed when the young rice plants reached what is known as the end of the "seedling stage". One set of cultures, however, was run to the full maturity of the grains produced.

REVIEW OF LITERATURE

The literature on the water requirements of plants in general was found by Briggs and Shantz (1913) to be very extensive. Their review includes only the literature on the subject prior to the year 1913. Much has been published on this subject in the last twenty years. Because of the extent of the literature no attempt was made in the present study to make a thorough review of it. The review was limited to studies on the water requirement or water need of rice plants. Fortunately, in the work of Briggs and Shantz, valuable information on the subject is assembled. Among other things, these authors report that the following generalizations have been revealed by the extensive literature that they studied:

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[1] Thesis presented for graduation from the College of Agriculture, Los Baños, 1933 with the degree of Bachelor of Agriculture, No. 463; Experiment Station contribution No. 1057. Prepared in the Department of Plant Physiology under the direction of Dr. R. B. Espino.

(*a*) That there was "an increase in the water requirement when the water content of the soil approaches either extreme". According to the literature, extreme moisture conditions might affect the water requirement indirectly, because with a high water content, soil solution is diluted and aëration is reduced. On the other hand, with a low water content, the water requirement of plants again becomes high "due to a deficiency of plant food".

(*b*) That the water requirement of plants "is affected by the kind of soil used. The factor influencing the water requirement seems, however, to be plant food rather than the type of soil". Water requirement is higher in a poor soil than in a fertile soil.

(*c*) That "with the exception of the potash series, the unfertilized check gave the highest value. Nitrogen reduced the water requirement decidedly, whether alone or in combination with phosphorus or potash". The lowest water requirement was obtained from cultures which contained "a combination of potash, nitrogen and phosphorus".

(*d*) That the use of fertilizers decreased the water requirement of plants. "In poor soils the water requirement may be reduced one-half or even two-thirds by the addition of fertilizers."

(*e*) That "the water requirement is profoundly affected by atmospheric conditions", as shown by the fact that water requirement studies "conducted during different periods of the year show great differences."

(*f*) That "shading produces an increase in the water requirement", because it reduces photosynthesis. This would, in turn, decrease the rate of growth and so increase the water requirement.

(*g*) That "the water requirement is greater in dry than in moist air."

(*h*) That "a nearly matured plant has lower water requirement than a young plant."

Available literature on the growth and development and yield of rice plants as influenced by water or by the moisture content of the culture media was limited, especially that on the upland, varieties. On the upland rice variety only one report was available, that of Reyes (1921) in which it was reported that the yield of grain of the rice plant was directly proportional to the amount of water used.

This author reported that in some cases the transpiration ratio was higher in the saturated soil than in the soil that contained less moisture.

On the lowland varieties, several papers, most of them from this College were available. A review of these papers should be of interest as they bear on the important question of the "duty of water" in the rice paddies, but this is not directly related to the problem involved in the present study. Ricafrente (1921) reports that running water 10 centimeters deep through the rice paddy continuously from transplanting till maturity proved to be the best method of application of water to Macan piña. But, he reports also that a supply of 20 centimeters deep produced the highest yield both in grain and in straw, and that a supply of 3 centimeters deep gave the lowest yield. Ricafrente further reports "that the proportion of weight of grain to weight of straw in this method of irrigation was about two-thirds to one". One striking result that was obtained from his study was that the high yield of straw was not accompanied by a corresponding high yield of grain when rice plant was supplied with water 18 centimeters in depth up to bearing time or maturity, after which no water was supplied.

Seven similar studies on the depth of irrigation water for lowland rice in western Laguna were summarized by Gordon (1929). This writer reports that the soil in the rice fields studied is clay-loam; that 11.1 centimeters was the average depth of irrigation water used; that the average depth of irrigation water used for each variety was 6.2 centimeters for Binangbang puti; 12.3, for Binicol; 10.1, for Guinangang; 9.3, for Inadhika; 2.9, for Macan; 9.0, for Mangasa; 2.6, for Nagsalit; and that the average depth was 7.5 centimeters.

Of the studies made in other countries, two were available. Robertson (1917) found that the best time to begin to submerge the paddy was when the rice plant was about 30 days old, and that the best depth of submergence was 6 inches (15.2 centimeters). Adams (1920) found that in certain stations "maximum rice yields" were obtained "from submerging rice fields 6 inches deep beginning 30 days after submergence of the plants above ground". However, an exception "was found on the alkali soils in the Norman plots, from which the best yields were obtained from submergence beginning 15 days after emergence". Adams also reports that keeping "rice fields only moist or 'muddy' throughout the growing season gives reduced yields of poor quality".

OBJECT, TIME AND PLACE OF THE STUDY

The object of this study was to determine the effects upon the growth and development of an upland rice of varying the moisture content of the clay-loam soil in pots.

The experimental part of this study was begun on December 20, 1931 and ended on February 23, 1933. It was carried out near the Plant Physiology Building of the College of Agriculture, Los Baños.

MATERIALS AND METHOD

The plants

Upland rice plants, variety Kinandang pute, were used in this study. They were started from seeds, which were obtained from a farmer in Los Baños. The seeds were soaked in water for 12 hours and then sown in pots containing ordinary garden clay-loam soil, four seeds to each pot. When the young plants produced were about ten centimeters high, some of the seedlings were pulled out, leaving only two plants in each pot. These plants were apparently uniform in size and state of development.

The soil

Ordinary clay-loam soil was used as the solid medium in this study. The soil was obtained from the Experimental Garden of the Department of Plant Physiology. It was pulverized, sieved and thoroughly mixed and put in pots of two sizes, as follows:

Small pots. In each set of cultures, thirty of the smaller pots or porcelain tumblers (see fig. 3), were filled with the clay-loam soil, each pot containing 800 grams.

Large pots. In each set of cultures, thirty of the larger pots, or empty kerosene cans (see fig. 1) were filled with the soil, each pot containing 19 kilograms.

The culture media

Cultures in smaller pots. Each set consisted of ten cultures and each culture was run in triplicate. The ten cultures contained different amounts of water. The soil in culture I was over-saturated; culture II contained 100 per cent saturation; culture III, 90 per cent; culture IV, 80 per cent; culture V, 70 per cent; culture VI, 60 per cent; culture VII, 50 per cent; culture VIII, 40 per cent; culture IX, 30 per cent, and culture X, 20 per cent saturation. The water saturation percentages were determined as follows:

The original moisture content of the soil was first determined. Samples of the soil were taken from a pile of the air-dried soil used in a set of cultures and weighed. Later, each sample was dried to a constant weight in a Freas' electric oven. From the data thus far obtained, the percentage of moisture in the soil was determined.

The total amount of moisture in the soil in each pot was next determined. Since there were 800 grams of soil in each pot and the percentage of moisture in the soil was known, then 800 grams multiplied by the moisture percentage gave the total amount of moisture in the soil in each pot.

Lastly, the different percentages of water saturation used in this study were determined, as follows:

To the 800 grams of soil in a pot, water was added little by little until the soil was saturated, that is, the water was to the level of the soil. The amount of water thus added plus the original amount of water present in the soil in the pot was arbitrarily considered as 100 per cent saturation. On the basis of the amount of water contained in the 100 per cent saturation, the percentages 90, 80, 70, 60, 50, 40, 30 and 20 of water saturation in the other culture media were computed. In the over-saturated cultures free or standing water was about one and a half centimeters above the surface of the soil in pots.

Cultures in larger pots. Each set consisted of ten cultures and each culture was run in triplicate. The ten cultures contained water in different amounts. The soil in culture I was over-saturated; culture II contained 100 per cent saturation; culture III, 90 per cent; culture IV, 80 per cent; culture V, 70 per cent; culture VI, 60 per cent; culture VII, 50 per cent; culture VIII, 40 per cent; culture IX, 30 per cent, and culture X, 20 per cent saturation. The water saturation percentages and other treatments were prepared as in the cultures in the smaller pots, except that the amount of soil used was 19 kilograms instead of 800 grams. In the over-saturated cultures free or standing water was about five centimeters above the surface of the soil in pots.

How moisture content was maintained or restored

Weekly determinations of the amount of water lost from each culture were made. One sample of soil from each pot was taken. This sample was obtained by boring with a soil auger to the bottom of the pot. The samples were dried to constant weight in a Freas' electric oven, then the percentages of moisture in the samples were determined. Knowing the original weight of the soil in each pot, and also knowing the percentages of moisture in the pot, it was easy to determine the total amount of water in the soil in that pot.

The amount of water thus found in each pot subtracted from the initial or original amount of water in the same pot gave a difference, in grams or kilograms, which was the amount lost during the week. To restore the original moisture content of each culture, an amount of water equivalent to the loss during the week was poured into the soil in the pot. This procedure was followed in determining the weekly loss of water from the smaller pots as well as from the larger ones. To effect an even distribution of water in the soil in the larger pots, small bamboo tubes with small holes in the sides were buried vertically in each pot. Water was gradually poured into the pot through these small tubes.

EXPERIMENTS AND RESULTS

Plan of the experiment and results obtained

Five sets of cultures were conducted in this study. Each set is here considered as an experiment. The rice plants in three of the sets of cultures were grown in the smaller pots and were harvested when the plants were forty days old. In the remaining two sets of cultures, the plants were grown in the larger pots. In one set of cultures, the plants were brought to maturity and produced grains. Owing to lack of time, the second set of cultures in which the larger pots were used was harvested when the plants were only forty days old. The object, the length of the culture period, and the number of replications of each culture in each experiment, may be given as follows:

Experiment 1. To determine the effects upon the growth and development of young rice plants of varying the moisture content of the clay-loam soil in pots. This experiment was started on December 24, 1931 and consisted of nine triplicate cultures. The plants were grown in the smaller pots, each pot containing 800 grams of the soil. On February 1, 1932, that is, when the plants were forty days old, the cultures were harvested and data under each of the criteria of results employed were obtained and were recorded in table 1.[2] The amounts of water that were added weekly to each of the cultures to replace the amounts of water lost or to restore the original moisture content of the soil in each culture were also given in table 1 (see table 2 for averages of data).

Experiment 2. To determine again the effects upon the growth and development of the young rice plants of varying the moisture content of the clay-loam soil in pots. This set of cultures consisting of ten was started on March 25, 1932. The nine triplicate cultures tried in experiment 1 were again tested. One culture in triplicate was added. In this culture the young rice plants were more liberally supplied with water than in experiment 2 as the standing water in each pot was one and a half centimeters above the surface of the soil.

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[2] Tables 1, 3, 5, 7, 9 are not included in this publication. They are on file in the Department of Plant Physiology.

On May 3, 1932, when the plants were forty days old, all the cultures were harvested. The experimental data gathered under each of the criteria of results employed together with other pertinent data were recorded in table 3 (see table 4 for averages of data).

Experiment 3. To determine the effects upon the growth and development of the rice plants of varying the moisture content of the clay-loam soil in the larger pots. In this set of cultures the treatment was similar to the two previous experiments except that larger pots, each containing 19 kilograms of soil, were used. The experiment was started on May 19, 1932 and ended on September 25, 1932. The plants reached full maturity and produced grains.

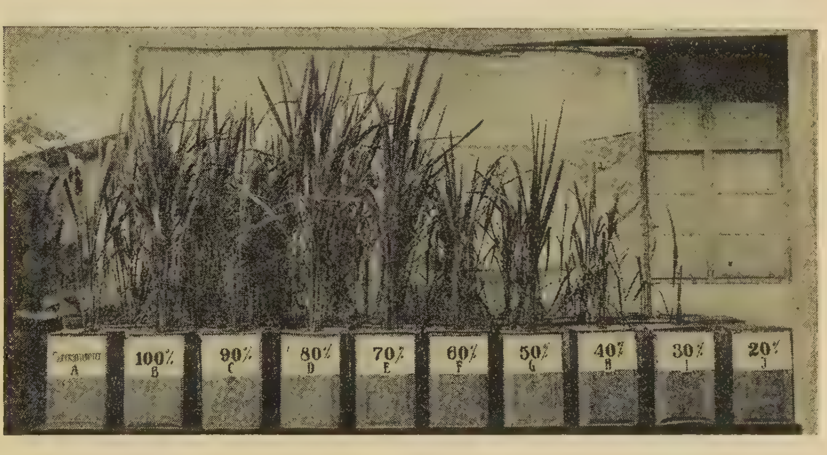

Fig. 1.—Showing the relative states of development of the rice plants in experiment 3, at the time of flowering. The plants were grown in clay-loam soil containing water in varying amounts, as shown on labels on pots. (Photograph taken August 11, 1932.)

On August 11, 1932, when flowers began to appear, the cultures were photographed (see fig. 1), and at the time of harvest, the cultures were photographed again (see fig. 2). Then, the plants from each culture were harvested and experimental data under each of the criteria of results employed together with other pertinent data were recorded in table 5 (see table 6 for averages of data).

Other data that were obtained from this set of cultures but are shown only in table 6 were the following: The plants in culture IV matured the earliest, the grains matured in 102 days; those in culture I, in 114 days; those in culture II, in 108 days; those in culture III, in 103 days; those in culture V, in 115 days; those in culture VI, in 120 days; those in culture VII, in 130 days; and those in culture VIII, in 131 days. The plants in culture IX did not flower at all.

Experiment 4. To determine a second time the effects upon the growth and development of young rice plants of varying the moisture content of the clay-loam soil in smaller pots. The experiment was started on October 20, 1932 and ended on November 29, 1932. This set of cultures was a repetition of those tried in experiments 1 and 2 and the original data obtained were recorded in table 7 (see table 8 for summary of the data). At the time of harvest. the cultures were photographed (see fig. 3).

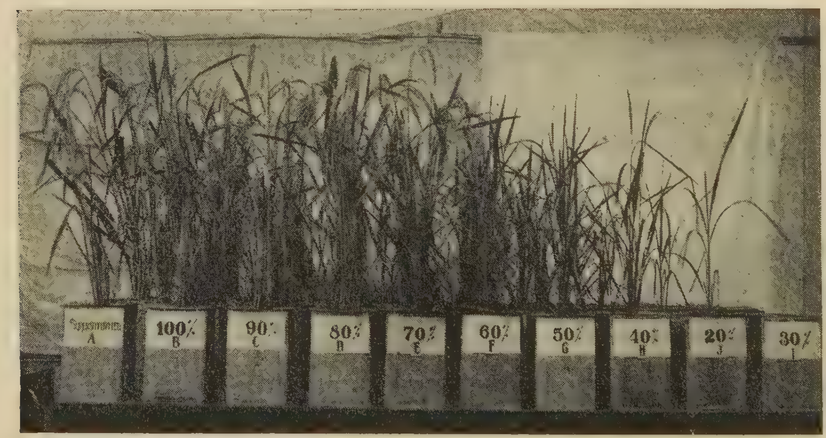

Fig. 2.—Showing the relative appearance of the same rice plants shown in figure 1 at the time of harvest, or when grains in some cultures were ripe. (Photograph taken September 25, 1932.)

Experiment 5. To determine a third time the effects upon the growth and development of the rice plants of varying the moisture content of the clay-loam soil in larger pots. This experiment was started on January 14, 1933 and closed on February 23, 1933. This set of cultures was intended to be a repetition of experiment 3, but owing to lack of time at the disposal of the writer, the plants were harvested when they were only forty days old. At the time of harvest, the cultures were photographed (see fig. 4). Afterwards, the cultures were harvested and the original data obtained under each of the criteria of results employed were reported in table 9 (see table 10 for summary of the data).

Criteria of results

The experimental data in this study were gathered under a number of criteria. Of course, the best criterion is the yield of grain, and the next best is probably the yield of straw, as it is an excellent expression or indication of the vigor of the plant. However, not all the cultures tried were allowed to reach maturity, the object in this case being to determine the amount of water in the soil in pots that would promote the growth and development of young rice plants. To understand how the data under the different criteria of results used were obtained, the following notes are given:

External appearance of plants. At the end of the experimental period, the general appearance of the plants grown in the different cultures was noted. The results of this observation were recorded in tables 1, 3, 5 and 7.

Height of top. At the time of harvest, the heights of tops of the plants from each of the triplicate cultures were measured in centimeters from the base of the stem to the tip of the highest leaf.

Length of root. The data under this criterion were obtained by measuring the length of the roots from each culture from point of attachment of the seed to the stem to the tip of the longest root.

Number of culms. At the time of harvest, the culms produced by the two seedlings planted in each pot were counted. The number of bearing and non-bearing culms were noted.

Dry weight of tops. At the time of harvest, the tops of the plants from each culture were cut off close to roots. The tops obtained from the different cultures were dried in an electric oven at a temperature of about 100°C. After drying, the tops from the different cultures were weighed separately, and the data thus obtained represent the dry weight of the tops of the plants.

Dry weight of root. The roots obtained from the different cultures in a set were also dried in an electric oven. Then they were separately weighed.

Dry weight of top and root. The dry weight of the top from a culture and the dry weight of the root of same plant were added together. The sum constitutes the dry weight of plants from the cultures.

Air-dry weight of top. The straw from each of the cultures that were allowed to reach full maturity was gathered and dried in the laboratory, then weighed.

Air-dry weight of root. The roots from the different cultures that were allowed to bear seeds were dried in the air in the laboratory, then weighed.

Air-dry weight of grains. When sufficiently ripe, the grains produced from each culture were gathered and allowed to dry in the air in the laboratory, then, both the empty and the good grains were weighed.

Air-dry weight of top, root and grains. To find the air-dry weight of the whole plants from each culture, the air-dry weights of top, root and of grains from each culture were added.

Water requirement. The term "water requirement", as was originally used by Briggs and Shantz, was the ratio of the weight of water absorbed by a plant during its life time and the weight of dry matter produced, not including the roots. In the present study, however, it was not possible to prevent escape of water directly from the pots. Consequently, "water requirement" was used to mean the ratio of the amount of water lost, in cubic centimeters [3], from each culture medium, and the dry weight, in grams, of tops and roots of the young plants. In the case of the larger cultures, the "water requirement" was the ratio of the amount of the water lost, in cubic centimeters, from a culture and the air-dry weight, in grams, of tops, roots, and grains combined obtained from the same culture. The data on "water requirement" of the rice plants are recorded in table 11, and should be read as the amount of water (in grams) needed to produce one gram of dry matter.

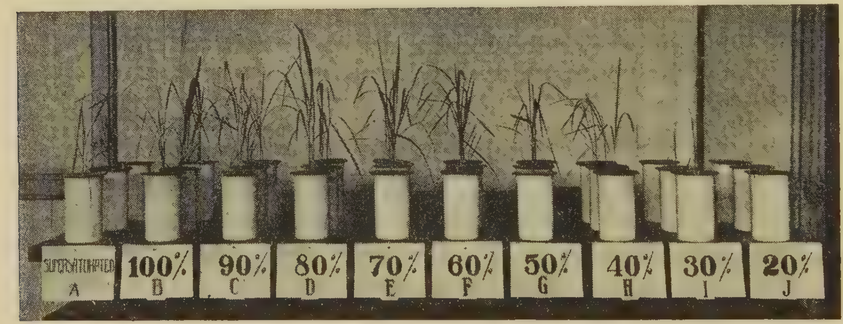

Fig. 3.—Showing the relative appearance at time of harvest of the 40-day old rice plants in the different cultures in experiment 4.

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[3] It was assumed that 1 cc. of water under room temperature weighed, or was equivalent to 1 gram.

DISCUSSION OF RESULTS

The data which were obtained in this study for the young (40 days old) rice plants, var. Kinandang pute, grown in pots containing clay-loam soil with varying moisture content will be discussed first, then, the data for the full grown rice plants, and lastly, the data on water requirements of the young and the mature rice plants.

For the sake of simplicity in discussion, only the data as averages given in tables 2, 4, 8, and 10 for younger plants, and in table 6, for older plants, together with the data on "water requirement" of the plants, will be considered in determining the relative effects on growth and development of the rice plants as influenced by the moisture content of clay-loam soil in pots.

Growth and development of young rice plants as influenced by varying the moisture content of clay-loam soil

Examination of the data in tables 2, 4, 8 and 10, and of figures 3 and 4 shows that the cultures which were supplied with water, at the rate of 20 per cent saturation, failed to produce any plant at all; the seeds started to germinate but the young plants produced did not continue to grow. The data in these tables also show that the yield of tops of the cultures in which the moisture content was 60 per cent saturation or lower was rather low; the yield of top decreased as the moisture content was diminished. The data also show that the cultures in which the degree of moisture saturation of the clay-loam soil in pots was 70 per cent or higher produced fairly well developed young plants as indicated by height and dry weight of top.

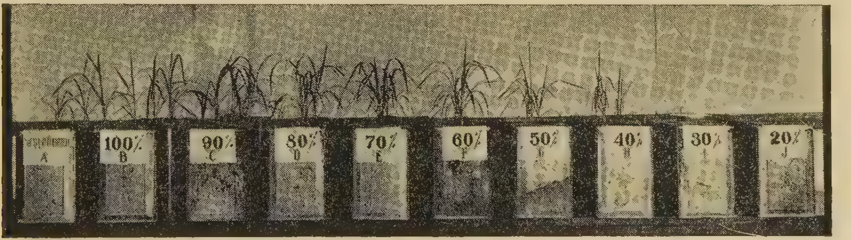

Fig. 4.—Showing the relative appearance at time of harvest of the 40-day old rice plants in the different cultures in experiment 5.

In tables 2, 4, 8, and 10 are also shown data on roots of the young rice plants. As was to be expected, the development of the roots in the different cultures was somewhat influenced by the moisture content of the soil. Except in one instance (culture VI shown in table 2), the lengths of roots produced in the different sets of cultures began to decrease as the moisture content, starting from the 50 per cent saturation, was diminished. The data also show that at 50 per cent saturation or lower, the yields of roots, in term of dry weight, were relatively low,—lower than the yields of roots from any of the other cultures tried in which the moisture content was 60 per cent saturation or higher. In other words, the relatively high yields of roots of the young plant were obtained from the cultures in which the moisture content of the clay-loam soil in pots was 70, 80, 90, and 100 per cent saturation; although in 100 per cent and in the supersaturated cultures, decrease in yields of roots was quite apparent.

In tables 2, 4, 8, and 10 it is also shown that, in term of dry weight of top and root combined, the development of the young rice plant was materially influenced by the moisture content of the soil. Relatively low yields were obtained from cultures in which the moisture content was 60 per cent saturation or lower, and the yields decreased as the moisture content of the media was decreased. In the same tables it may also be seen that the yields of tops and roots combined relatively decreased in the culture media which were either 100 per cent saturation or supersaturated. The highest yields of the young plants, in term of dry weight of top and root, may, therefore, be found in the cultures in which the moisture content of the soil was 70, 80, and 90 per cent saturation.

To select the culture medium in which the moisture content of the soil was apparently most suitable for the young rice plant, the two highest figures under each of the criteria of results employed are indicated by H's in tables 2, 4, 8, and 10. On further examination of the contents of these tables, it may be seen that the culture medium in which the soil was 80 per cent saturation received all or most of the H's. Therefore, as far as the degree of saturation is concerned, this culture medium was the best for the young rice plant, especially, as this finding is borne out by the experimental data that were obtained from the four sets of cultures tried. However, because the relatively high values indicated by H's were also found in the culture media that contained 70 and 90 per cent saturation, it may be safe to say that the moisture content best for the young rice plant ranged from 70 to 90 per cent saturation. It is possible that there were similarities of results obtained from young rice plants that were grown in pots containing 800 grams of soil each and those grown in pots containing 19,000 grams (or 19 kilograms) of soil each. In other words, irrespective of the size of pots or of the amount of clay-loam soil used, the best result, as judged from the data under the different criteria employed, was obtained from the culture media that had 80 per cent saturation, and that the range of promising culture media for the young rice plant appears to be from 70 to 90 per cent saturation.

Varying the moisture content of soil and its effects upon rice plants as indicated by yields of straw, roots and grain

The data in tables 4 and 6 and figures 1 and 2 again show that the culture media which contained 20 per cent saturation failed to produce plants of appreciable size. The seeds germinated but the young plants produced soon died. Moreover, cultures VI, VII, VIII, and IX, did not produce plants of any appreciable size—that is, when compared with those produced by the other culture media in which water was supplied more liberally. It appears, therefore, that 60 per cent saturation or lower was inadequate for the proper or full development of the rice plant.

Turning to the culture media which were more liberally supplied with water, it may be seen in tables 4 and 6 and in figures 1 and 2 that at the time of harvest, the plants in cultures I to V, inclusive, were about equally well developed and produced relatively high yields of grain, corroborating Reyes' (1921) report that the yield of grain of the rice plant was materially influenced, and favorably, by the amount of water used. It appears, therefore, that the most promising culture media for the plant, as indicated by the data under the criteria of results employed at the time of harvest, ranged from 70 per cent saturation to a supersaturated condition.

Two things of great interest, however, were noted during the progress of this experiment. It was noted (see fig. 1) that on or about August 11, 1932, the plants in the supersaturated culture media were not as tall nor as well developed as those in cultures II, III, IV and V in which the moisture content of the soil was 100, 90, 80, and 70 per cent saturation. But, at the time of harvest, or on September 25, 1932 (see fig. 2) the plants in culture I, judged by the criteria employed, were as good as or even better than those produced in the other cultures. Moreover, it was also noted that the moisture content of the soil in pots had material influence on the rate of maturing of grain. Table 6 shows that although the plants in culture I (supersaturated) caught up with the other cultures in general development of the vegetative organs and in the yield of grain, it took 114 days to bring the grain to complete maturity. On the other hand, under the same criterion, cultures II, III and IV each required less time to bring the grain to ripeness. Cultures III and IV produced ripe grains in 103 and 102 days, respectively. It appears, therefore, that 90 and 80 per cent saturation were conducive to early ripening of grain and with an increase or a decrease from these saturations, moisture content of clay-loam soil from either of two percentages of saturation materially caused a delay in the ripening of the grain.

Water requirements of young and of full-grown rice plants

Before considering the "water requirement" of the rice plant, it may be of interest to note that, as was to be expected, the weekly additions of water to the different cultures increased with the age of the plants and decreased with the decrease in the moisture content of the clay-loam soil in pots. These two generalizations seem to be supported by the data on *weekly addition of water to culture* recorded in tables 1, 3, 5, 7, and 9. Thus, as shown in tables 2, 4, 6, 8 and 10, the total amounts of water (average of triplicate cultures) in the different cultures in each of the five sets tried, decreased more in proportion to the decrease in the moisture content of the soil than to the degree of development of the rice plants, expressed in term of dry matter of the plant. This finding seems to suggest either that absorption of water from the culture media was facilitated by the relative abundance of water supply in pots or that the rate of direct loss of water from the pots was proportional to the moisture content of the soil in pots. In the present study no attempt was made to determine which of the two suppositions was correct. However, it was suspected that the relative sizes of the plants and the relative abundance of water in the different cultures in a set might have contributed to the relatively more rapid losses of water from certain cultures and to the rather slow losses from the others.

Considering the data on "water requirement" of young and of full-grown rice plants (see table 11), it will be seen, that without exception, culture IV, which contained 80 per cent saturation the culture media best for the young rice plants, had the lowest record on "water requirement" in each of the five sets of cultures tested. As the moisture content in the culture media was increased or decreased beyond a certain point, there was a corresponding increase in "water requirement". In other words, the culture media in which the moisture content was 80 per cent saturation required the minimum amount of water to produce a maximum yield of dry matter. To produce the same amount of dry matter of the plants grown in the other cultures required a greater amount of moisture. This finding corroborates Briggs and Shantz (1913) report to the effect that there was "an increase in the water requirement when the water content of the soil approaches either extreme". According to the literature consulted, extreme moisture conditions might affect the water requirement indirectly, because with a high water content, soil solution is diluted and aëration is reduced. On the other hand, with a low water content the water requirement of a plant again becomes high "due to a deficiency of plant food."

Data in table 11 also show that the cultures in experiment 1 required less amount of water to produce one gram of dry matter of the young rice plants than the corresponding cultures in experiments 2 and 4. Conditions in these three experiments being identical, except the aërial environment of the plants, it may, therefore, be suspected that the water requirement of the plant was subject to the influence of its aërial environment. According to Briggs and Shantz (1913) "the water requirement is profoundly affected by atmospheric conditions", as shown by the fact that water requirement studies "conducted during different periods of the year show great differences".

Data in table 11 further show that on the whole the "water requirement" of the 40-day old rice plants was greater than that of the full-grown rice plants. In other words, to produce a certain amount of dry matter, the younger rice plants required more water than the older, or full-grown plants. However, this conclusion should be considered as only tentative and data on water requirements of this plant should be gathered from cultures in which no loss of water is possible except through the body of the plant itself, although Briggs and Shantz (1913) found in the literature that "a nearly matured plant has lower water requirement than in young plant."

SUMMARY AND CONCLUSIONS

Under the conditions of this study and with the data on hand, it appears possible to make the following generalizations:

1. Irrespective of the size of pots or of the amount of clay-loam soil used, the best result, as judged from the data obtained under the criteria employed, was obtained from the culture media that had 80 per cent saturation. The range of promising culture media for the young upland rice plant, var. Kinandang pute, appears to be from 70 to 80 per cent saturation.

2. Culture media containing 20 per cent saturation either failed to produce any plant or the seeds germinated but the young plants did not continue to grow to the time of harvest.

3. Cultures containing clay-loam soil with moisture content of 60 per cent saturation or lower produced rather poorly developed rice plants; the yield of top and of roots decreased as the moisture content of the soil in pots was diminished.

4. It appears that 90 and 80 per cent saturation were conducive to early ripening of grain of the rice plant, and an increase or a decrease in moisture content of clay-loam soil from either of the two percentages of saturation, caused a noticeable delay in the ripening of the grain.

5. The culture media in which the moisture content was 80 per cent saturation required the minimum amount of water to produce a maximum yield of dry matter. To produce the same amount of dry matter, the plants grown in the other cultures required a greater amount of moisture.

6. Roughly, the water requirement of the 40-day old upland rice plants, var. Kinandang pute, was greater than that of the full-grown plants. This conclusion, however, should be further verified by growing the rice plant in culture media from which there would be no loss of water except through the body of the plant itself.

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TABLE 2

Showing averages of data under different criteria obtained from the different triplicate cultures reported in table 1

CULTURE NO.	PERCENTAGE OF SATURATION	AMOUNT OF WATER ADDED	HEIGHT OF TOP	LENGTH OF ROOT	DRY WEIGHT		
					Top	Root	Top and root
		cc.	*cm.*	*cm.*	*gram*	*gram*	*gram*
I	100	498.4	35.2	12.5	.3149	.1191	.4340
II	90	451.3	33.6	12.9	.3499 H	.1223	.4722 H
III	80	424.9	41.6 H	12.4	.3609 H	.1880 H	.5489 H
IV	70	274.1	37.6 H	11.2	.2812	.1605 H	.4417
V	60	257.8	36.5	15.9 H	.2356	.1582	.3938
VI	50	219.1	36.3	17.3 H	.2255	.0905	.3193
VII	40	216.1	24.8	10.0	.1354	.0947	.2335
VIII	30	136.3	20.6	5.0	.0915	.0519	.1435
IX	20	—	—	—	—	—	—

TABLE 4

Showing averages of data under different criteria obtained from the different triplicate cultures reported in table 3

CULTURE NO.	PERCENTAGE OF SATURATION	AMOUNT OF WATER ADDED	HEIGHT OF TOP	LENGTH OF ROOT	DRY WEIGHT		
					Top	Root	Top and root
		cc.	*cm.*	*cm.*	*gram*	*gram*	*gram*
I	Super-saturated		42.8 H	14.8	.4243	.1817 H	.6060
II	100	947.6	38.5	17.2 H	.4491	.1537	.6019
III	90	895.5	40.1	17.1	.4548	.1651	.6199 H
IV	80	881.2	42.5 H	20.9 H	.5727 H	.2413 H	.8139 H
V	70	730.2	40.3	16.5	.4611 H	.1487	.6098
VI	60	547.7	35.7	13.3	.3547	.1503	.5050
VII	50	450.3	28.4	9.1	.2477	.1107	.3584
VIII	40	301.3	22.6	8.0	.1469	.0719	.2188
IX	30	176.2	22.5	8.7	.1157	.0646	.1803
X	20	—	—	—	—	—	—

TABLE 6

Showing averages of data under different criteria obtained from different triplicate cultures reported in table 5

CULTURE NO.	PERCENTAGE OF SATURATION	AMOUNT OF WATER	NUMBER OF CULMS		HEIGHT OF TOP	LENGTH OF ROOT	DRY WEIGHT				TIME FROM PLANTING TO MATURITY OF GRAIN[a]
			Bearing	Non-bearing			Top	Root	Grain	Top, root and grain	
		cc.			*cm.*	*cm.*	*grams*	*grams*	*grams*	*grams*	*days*
I	Super-saturated	—	8	4	132.0	43.8	41.0	17.2	18.3	76.5	114
II	100	42,884	11	4	126.0	29.1	52.4	12.3	18.2	82.9	108
III	90	37,545	8	4	125.0	35.5	47.5	15.7	14.3	77.5	103
IV	80	33,831	8	3	126.0	35.0	50.8	16.9	16.2	83.9	102
V	70	31,154	7	1	128.0	30.7	38.2	6.8	18.9	63.8	115
VI	60	21,854	6	2	117.8	20.4	28.4	6.0	4.4	46.2	120
VII	50	14,067	1	6	102.0	29.4	21.9	4.8	0.9	27.7	130
VIII	40	9,452	1	4	96.0	29.9	12.5	2.6	1.1	16.1	131
IX	30	5,834	0	2	89.0	21.5	4.8	1.5	0	6.3	Did not flower
X	20	—	—	—	—	—	—	—	—	—	No seed germinated

[a] Maturity of grains was indicated by their yellow color.

TABLE 8

Showing averages of data under different criteria obtained from the different triplicate cultures reported in table 7

CULTURE NO.	PERCENTAGE OF SATURATION	AMOUNT OF WATER ADDED	HEIGHT OF TOP	LENGTH OF ROOT	DRY WEIGHT		
					Top	Root	Top and root
		cc.	*cm.*	*cm.*	*gram*	*gram*	*gram*
I	Super-saturated	—	39.1	13.7	.2554	.0843	.3397
II	100	642.5	38.7	20.9	.1851	.1459 H	.3310
III	90	615.9	42.8	19.1	.3643 H	.1371	.5013 H
IV	80	565.9	46.8 H	24.8 H	.4573 H	.2375 H	.6955 H
V	70	518.6	45.4 H	24.3 H	.3530	.1327	.4857
VI	60	471.1	44.5	21.4	.2531	.0947	.3478
VII	50	366.4	34.9	15.2	.1691	.0652	.2343
VIII	40	319.2	31.2	10.2	.1037	.0457	.1527
IX	30	192.6	19.9	12.8	.0687	.0614	.1199
X	20	—	—	—	—	—	—

TABLE 10

Showing the average data under different criteria obtained from the different triplicate cultures reported in table 9

CULTURE NO.	PERCENTAGE OF SATURATION	AMOUNT OF WATER ADDED	HEIGHT OF TOP	LENGTH OF ROOT	DRY WEIGHT		
					Top	Root	Top and root
		cc.	*cm.*	*cm.*	*grams*	*gram*	*grams*
I	Super-saturation	—	48.8	10.4	1.5838	.1562	1.7390
II	100	3851	51.8	9.8	2.3066	.1359	2.4425
III	90	3516	54.9 H	11.7	3.4111 H	.2134	3.6345 H
IV	80	3349	60.6 H	12.3 H	4.3356 H	.3445 H	4.6805 H
V	70	3280	49.1	10.3	2.8709	.3895 H	3.2917
VI	60	3182	48.7	12.5 H	2.3621	.2505	2.6093
VII	50	3086	42.3	9.9	1.3941	.1670	1.5608
VIII	40	2753	31.8	9.6	0.7906	.0705	0.5278
IX	30	2436	22.0	4.5	0.1309	.0324	0.1667
X	20	—	—	—	—	—	—

TABLE 11

Showing average of data on the water requirements of the rice plants obtained from tables 2, 4, 6, 8 and 10

CULTURE NO.	MOISTURE CONTENT OF THE CLAY-LOAM SOIL	AVERAGE WATER REQUIREMENTS IN CC.[d] OF EACH OF THE TRIPLICATE CULTURES IN DIFFERENT EXPERIMENTS					
		EXPERIMENT 1[a]	EXPERIMENT 2	EXPERIMENT 4	AV. OF EXPERIMENTS 1, 2 AND 4	EXPERIMENT 3[b]	EXPERIMENT 5[c]
I	Super-saturated	—	—	—	—	—	—
II	100	1148	1558	1948	1549	529	1659
III	90	956	1283	1229 L	1156	497	965 L
IV	80	592 L	1083 L	814 L	830 L	405 L	716 L
V	70	621 L	1197 L	1045 L	954 L	488 L	996 L
VI	60	655 L	1086 L	1355	1032 L	473 L	1220
VII	50	655	1256	1564	1158	543	1977
VIII	40	921	1382	2089	1464	603	4837
IX	30	950	977	1606	1178	942	14613

[a] The plants in experiments 1, 2, and 4 were grown in 800-gram tumblers and harvested when the plants were 40 days old.

[b] The plants in these cultures were brought to complete maturity and bore seeds.

[c] Young rice plants grown for 40 days in larger pots.

[d] 1 cc. of water was taken arbitrarily as equal to 1 gram. The three cultures under each experiment that showed relatively low "water requirements" were arbitrarily selected and each is indicated in the table by an L.

THE FEEDING VALUE OF CORN BRAN IN RATIONS FOR GROWING CHICKS [1]

CESAR S. TOLENTINO

WITH ONE CHART

In a previous paper, (Fernandez, 1934), the relative feeding values of *tahup sa mais* [2] and rice bran were compared in rations for laying hens. In this study, it was found that these two by-products have about the same feeding value for egg production, but a combination of the two is better than either alone. It should be of interest to determine whether or not corn bran would be a good feed for chicks. It was with this object that the study here reported was carried out. The experiments were conducted in the Department of Animal Husbandry of the College of Agriculture from February 3 to September 8, 1934.

PLAN OF THE STUDY

Chicks used. Artificially hatched Los Baños Cantonese chicks produced from the College flocks were used in this experiment. These chicks were brooded in fireless brooders made from empty kerosene boxes. The rearing quarters were about 2 meters wide and 4 meters long, enclosed by a one-inch mesh chicken wire.

Feeds used. All feeds given to the chicks were in the form of mash. They were corn meal (Calauan Yellow Flint), standard rice bran, corn bran (from Cebu White Flint variety) and shrimp meal.

The proximate analysis of the feeds used were as follows:[3]

COMPOSITION	FEEDS			
	Rice bran	Corn meal	Corn bran	Shrimp meal
	per cent	*per cent*	*per cent*	*per cent*
Moisture	9.20	12.48	10.67	14.55
Crude fats (Ether extract)	13.89	4.91	4.95	2.61
Ash	10.11	1.54	3.25	19.73
Proteins (N × 6.25)	12.38	9.37	9.69	55.61
Crude fiber	9.72	1.93	5.39	4.24
N. F. E.	44.70	69.77	66.05	3.26

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[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture, University of the Philippines No. 464; Experiment Station contribution No. 1058. Prepared in the Poultry Division, Department of Animal Husbandry, under the direction of Dr. F. M. Fronda.

Received for publication, January 29, 1935.

[2] *Tahup sa mais* is a dialect name for a by-product obtained in milling corn. As the process of its production is similar to that of rice bran, the name corn bran will be used in this College, hereafter, instead of *tahup sa mais*.

[3] Analyzed in the Chemistry Department, College of Agriculture.

The current prices per kilogram of the feeds at the time of the experiment were:

Rice bran	₱0.027
Corn	0.043
Corn bran	0.042
Shrimp	0.125

Methods. There were three trials in this experiment. The chicks that were hatched for each trial were divided equally among the five lots. There were 67 chicks in each lot. The ration given to each lot is shown in the following tabulation. The figures represent parts by weight.

LOTS	RATIONS USED				
	Rice bran	Corn meal	Corn bran	Shrimp meal	Total
I	8	0	0	2	10
II	0	8	0	2	10
III	0	0	8	2	10
IV	4	4	0	2	10
V	4	0	4	2	10

The chicks were self-fed, the ration being given in an open trough to which the chicks had free access. Clean drinking water and fresh green grass were available at all times.

Records. Careful observations on the behavior of the chicks were made from time to time during the course of the experiment. As the weights of the chicks at different ages were used as a criterion in determining the influence of the feeds on the growth, the chicks were weighed weekly from the first day of the experiment till the end of the twelfth week and the individual weights recorded. The mortality of each lot was also recorded. The feed consumption of each lot was carefully determined. Other minor observations such as on health, vigor, feathering and the development of the sexual characters were recorded.

RESULTS AND DISCUSSIONS

Growth of chicks. The average weekly weights during the brooding period are given in table 1, and graphically presented in chart 1. By reference to table 1, it may be seen that there was not much difference in the initial weights of the chicks in the different lots. It may be observed also that from the first week to the second, there was no marked difference in the rate of growth of the chicks in the different lots. After this period, however, up to the end of the twelfth week the rate of growth was markedly different in the lots.

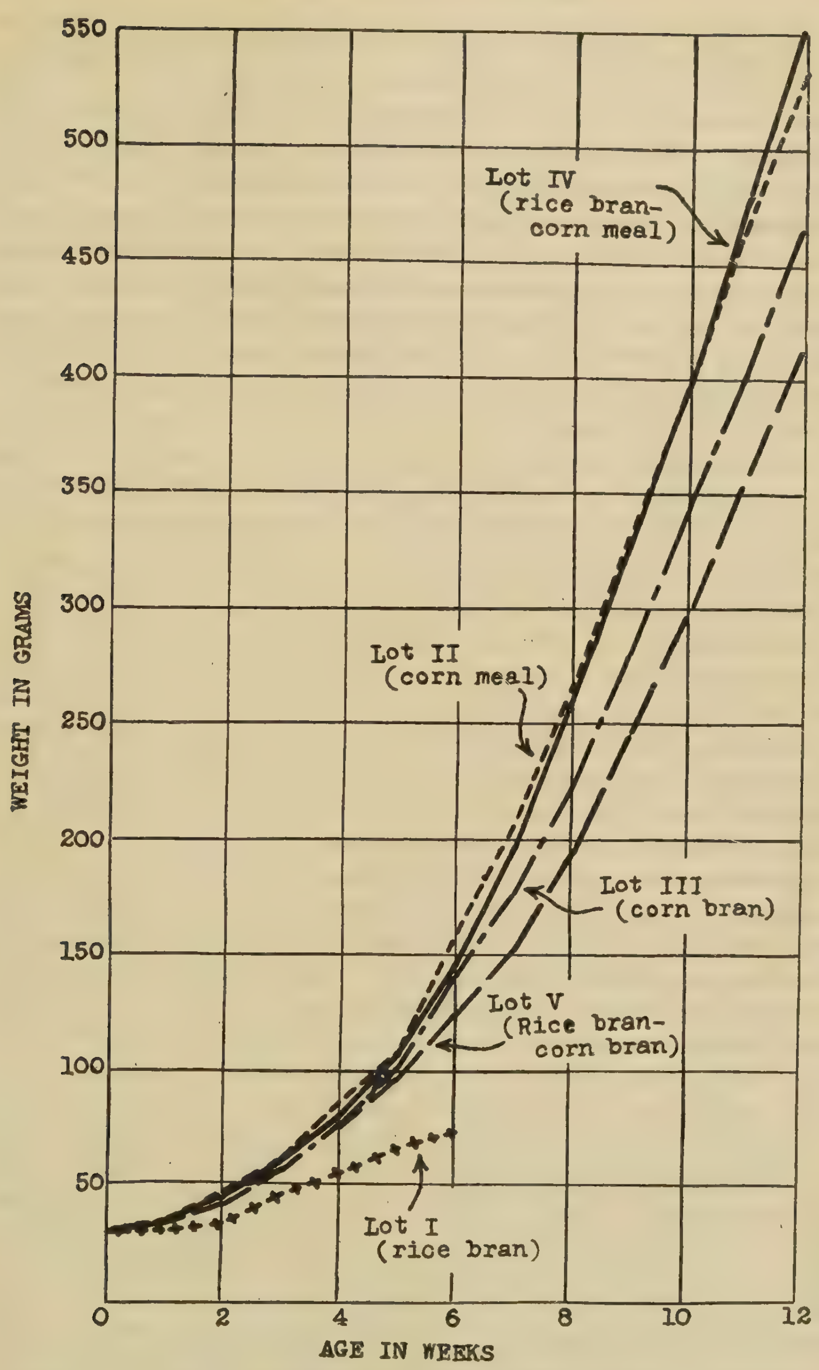

Chart 1.—Showing the weekly weights of chicks that were given rice bran (lot I), corn meal (lot II), corn bran (lot III), a combination of rice bran and corn meal (lot IV), and a combination of rice bran and corn bran (lot V) in the ration supplemented with shrimp meal.

It will be noted from the data that after the fourth week, lot I (rice bran lot) did not gain as much as the other lots in the same period. When the lots were compared, the differences between them were found to be significant, except between lots III (corn bran lot) and IV (corn meal-rice bran lot), and lots III and V (corn bran-rice bran lot). The difference between the lots were: Lots I and II, 31.1 ± 1.6356 grams; lots I and III, 21.6 ± 1.1807 grams; lots I and IV, 25.6 ± 1.1355 grams; lots I and V, 20.7 ± 0.8371 grams; lots II and III, –9.5 ± 1.9213 grams; lots II and IV, –5.5 ± 1.9183 grams; lots II and V, –10.4 ± 1.2319 grams; lots III and IV, 4.0 ± 1.5182 grams; lots III and V, –0.9 ± 1.3040 grams and lots IV and V, –4.9 ± 1.2632 grams.

At the end of the eighth week, the chicks in lot II (corn meal lot) weighed 265.2 ± 6.4769 grams. This lot registered the most rapid rate of growth and lot V (corn bran-rice bran lot) the slowest growth. At this time there were no birds left in lot I (rice bran lot) all having died before the seventh week. The difference in the mean weights between the different lots when treated statistically was significant in each case except between lots II (corn meal lot) and IV (corn meal-rice bran lot). The differences between the lots were: lots II and III, –44.2 ± 7.3930 grams; lots II and IV, –3.1 ± 8.0992 grams; lots II and V, –71.3 ± 7.2848 grams; lots II and IV, 40.0 ± 6.0318 grams; lots III and V, –27.1 ± 4.8860 grams; and lots IV and V, –68.0 ± 5.8978 grams.

At the age of twelve weeks, the mean weights of the different lots were: in lot II (corn meal lot), 532.5 ± 10.3188 grams; lot III (corn bran lot), 465.5 ± 6.5082 grams; lot IV (corn meal-rice bran lot), 557.6 ± 8.5011 grams; and lot V (corn bran-rice bran lot), 412.8 ±7.0722 grams. From these figures it may be seen that the lot IV chicks were the heaviest, followed very closely by those in lot II, the lot that registered the highest rate of growth up to the ninth week; those in lot III were third and those in lot V, fourth. In reports by previous investigators on Los Baños Cantonese fed with normal rations, the chicks weighed at the end of the twelfth week as follows: Mendoza (1925) reported 514.2 grams; Dañgilan (1926), 308.9 grams; Ordoveza (1927), 396.4 grams; and Tioaquen (1933), 460.5 grams. It is apparent that the weights obtained in the present study compare favorably with those obtained by these investigators. The chicks in lot III (corn bran lot), though third in rank as to weight, were heavier than some of the corresponding lots studied by previous workers.

In all the three trials this relationship among the different lots was observed. Possibly, the high gain in weight of lot II (corn meal fed lot) may be due to the high metabolizable net-energy of corn, as reported by Mitchell and Haines (1927). The conspicuous gain in weight made by lot IV (corn meal-rice bran lot) was probably due to the combination of corn meal and rice bran, the proteins of corn meal and rice bran mutually supplementing each other, as reported by Maynard, Fronda and Chen (1923).

Comparing the weights of the different lots at twelve weeks of age, it was observed that the differences between the lots when treated statistically were all significant except between lots II (corn meal lot) and IV (corn meal-rice bran lot). The differences between the lots were: lots II and III, –67.0 ± 12.1983 grams; lots II and IV, 25.1 ± 13.3685 grams; lots II and V, –119.7 ± 12.5117 grams; lots III and IV, 92.1 ± 10.7050 grams; lots III and V, –52.7 ± 9.6097 grams; and lots IV and V, –134.8 ± 11.0582 grams. These results show that corn bran is inferior to corn meal but superior to rice bran in rations for growing chicks. Considering the weights of the chicks in lot IV (corn meal-rice bran lot) as 100 per cent, that of lot II (corn meal lot) was 93.60 per cent; lot III (corn bran lot), 80.35 per cent; and lot V (corn bran-rice bran lot), 73.85 per cent.

Mortality of chicks. Table 2 shows the average percentage of mortality of the chicks up to 12 weeks old in the different lots. It may be seen from this table that lot I (rice bran lot) had the highest percentage of mortality; lot V (corn bran-rice bran lot), the second; lot III (corn bran lot), the third; lot II (corn meal lot), the fourth; and lot IV (corn meal-rice bran lot), the lowest. In lot I, with the ration containing rice bran fed alone supplemented with shrimp meal, the mortality so increased that at the end of the first week only 53.93 per cent of the chicks were living. At the termination of the fourth week only 22.40 per cent of the chicks were left and these died before the seventh week. This high increase in mortality would seem to be the result of the ration. Fernandez (1934) in a study on the relative value of corn bran and rice bran in rations for egg production reported that the rice bran lot had the highest percentage of mortality. According to Lamon and Lee (1929) rice hulls are worthless as poultry feed. Rice bran when not adulterated with hulls and when not containing over 12 per cent fiber is a nutritious feed when used in limited quantities with other feeds. It is evident that the too large amount of rice bran caused the injurious effect on the chicks in lot I, a result which is in accordance with Henry and Morrison's (1929) statement that too much rice bran is harmful. Probably, because of the injurious effect of rice bran the chicks in lot I (rice bran lot) were not vigorous, hence, their susceptibility to prevailing diseases.

This relationship between the different lots was noted in the three trials. The low percentage of mortality in lot IV (corn meal-rice bran lot) may have been due to the unified quality of rice bran and corn meal. Lot II (corn meal lot) had the second lowest percentage of mortality. Chan and Guiyab (1933) reported that corn-fed chickens had lower mortality than palay-fed chickens.

The average percentage of mortality in the different lots at the end of the experiment was: Lot I (rice bran lot), 100 per cent; lot II (corn meal lot), 32.81 per cent; lot III (corn bran lot), 40.27 per cent; lot IV (corn meal-rice bran lot), 26.85 per cent; and lot V (corn bran-rice bran lot), 47.76 per cent. These figures show that corn bran is very much better than rice bran when used singly, supplemented with shrimp meal in rations for growing chicks. However, corn bran fed singly or in combination with rice bran is inferior to either corn meal-rice bran or corn meal. The results show further that corn bran is not as good as corn meal with shrimp meal as supplement for growing chicks.

Amount and cost of feeds consumed. Table 3 shows the amount and costs of feeds consumed by the different lots raised to 12 weeks old. On an average, it was found that the amount of feed charged per bird was: 2.256 kilograms for lot II (corn meal lot); 2.143 kilograms for lot III (corn bran lot); 2.367 kilograms for lot IV (corn meal-rice bran lot); and 2.184 kilograms for lot V (corn bran-rice bran lot). Comparing these figures on the basis of 100 birds it will be seen that the average amount of feeds charged to lot II was 225.6 kilograms; to lot III, 214.3 kilograms; to lot IV, 236.7 kilograms; and to lot V, 218.4 kilograms. It may be seen that there was no marked difference in the amounts of feeds consumed by the different lots.

With calculations based on the market prices of the feeds, one kilogram of the ration for lot I (rice bran lot) cost ₱0.0460; lot II (corn meal lot), ₱0.0594; lot III (corn bran lot), ₱0.0586; lot IV (corn meal-rice bran lot), ₱0.0530; and lot V (corn bran-rice bran lot), ₱0.0486. With these different costs of feeds as basis of computation, it was found that the cost of feed needed to produce a weanling chick in lot II (corn meal lot) was ₱0.1328; in lot III (corn bran lot), ₱0.1251; and lot V (corn bran-rice bran lot), ₱0.1068.

The cost of feed necessary to produce a kilogram live fowl was ₱0.26 in lot II (corn meal lot); ₱0.29, in lot III (corn bran lot);

₱0.23 in lot IV (corn meal-rice bran lot); and ₱0.28 in lot V (corn bran-rice bran lot). It may be seen from these figures that it cost more to raise chicks in lot III (corn bran lot) than in any of the other three lots.

In efficiency, based on the amount of feeds consumed and using lot II (corn meal lot) and lot IV (corn meal-rice bran lot) as 100 per cent it may be seen that lot III (corn bran lot) was 91.63 per cent as efficient as lot II or IV.

The chicks in lot III (corn bran lot) and lot V (corn bran-rice bran lot) seemed to have a good appetite. They ate with apparent avidity, but they appeared to be always in search of something in their feed which they could not find.

Minor observations. During the experiment, the chicks were closely observed as to health, vigor, feathering, and the development of the sexual characters. Regarding their physical condition after the eighth week it was observed that lot III (corn bran lot) and lot V (corn bran-rice bran lot) did not have the same vigorous appearance as lot II (corn meal lot) and lot IV (corn meal-rice bran lot). It was particularly noticed that the general condition of feathers seemed slightly ruffled and unkempt in lots III and V as compared with lots II and IV. The general vigor and development of the birds did not appear equal to that of lots II and IV. These differences became more noticeable as the chicks grew older, until, at the end of the twelfth week when the experiment was closed, it was plainly seen that in physiological condition lots III and V were in no way equal to or as good as lots II and IV. Marked variation in the individual rates of growth occurred in lots III and V, which is an indication of an inadequate diet.

SUMMARY AND CONCLUSIONS

The results of a study on the feeding value of corn bran for growing chicks are reported and discussed in this paper. From the results obtained the following summary of conclusions may be drawn:

1. Corn bran is much better than rice bran when used singly supplemented with shrimp meal in rations for chicks; it is, however, decidedly inferior to corn meal alone.

2. The chicks that were fed corn bran and the ones fed corn bran and rice bran grew more slowly than the chicks fed corn meal or those fed corn meal and rice bran.

3. The corn meal-rice bran chicks grew the most rapidly, followed very closely by the corn meal fed chicks; the corn bran fed

chicks came third; and the corn bran-rice bran fed chicks were the slowest in growth.

4. At the age of twelve weeks there was no significant difference in weight between the corn meal fed chicks and the corn meal-rice bran fed chicks.

5. Rice bran when fed in large quantities proved to be an unsatisfactory feed for growing chicks.

6. There was no marked difference in the amounts of feed consumed by the different lots.

7. The average amount of feed charged per bird was 2.256 kgm. in the corn meal fed lot; 2.143 kgm. in the corn bran fed lot; 2.367 kgm. in the corn meal-rice bran fed lot.

8. It required 4.49 kgm. of feed to produce a kilogram live fowl in the corn meal fed lot; 4.90 kgm. in the corn bran fed lot, 4.49 kgm. in the corn meal-rice bran fed lot; and 5.66 kgm. in the corn bran-rice bran lot.

9. The cost of feed necessary to produce a kilogram live fowl was ₱0.26 in the corn meal fed lot; ₱0.29 in the corn bran fed lot; ₱0.23 in the corn meal-rice bran fed lot; and ₱0.28 in the corn bran-rice bran fed lot.

10. From the viewpoint of economy in poultry raising, it would seem that for growing chicks corn meal is a better feed than corn bran or a combination of rice bran and corn bran.

11. For growing stock, the combination of rice bran and corn meal is markedly better than corn bran or a combination of rice bran and corn bran.

12. The corn bran fed chicks and the corn bran-rice bran fed chicks were less vigorous than either the corn meal fed chicks or corn meal-rice bran fed chicks.

13. There was no marked variation in the individual growth rates in the corn bran lot and the corn bran-rice bran lot.

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TABLE 1

Showing the weekly weights of the chicks in the different lots

AGE	LOT I (RICE BRAN)		LOT II (CORN MEAL)		LOT III (CORN BRAN)		LOT IV (CORN MEAL-RICE BRAN)		LOT V (CORN BRAN-RICE BRAN)	
	Number of chicks	Mean weights	Number of chicks	Mean weights	Number of chicks	Mean weights	Number of chicks	Mean weights	Number of chicks	Mean weights
		grams		*grams*		*grams*		*grams*		*grams*
1 day	67	28.5 ± 0.6388	67	28.7 ± 0.1843	67	29.2 ± 0.2069	67	28.5 ± 0.5569	67	28.4 ± 0.5563
1 week	36	32.0 ± 0.3261	57	34.0 ± 0.3039	55	34.5 ± 0.2319	59	33.4 ± 0.2763	54	33.2 ± 0.3173
2 weeks	30	38.0 ± 0.3628	53	46.7 ± 0.5979	49	46.6 ± 0.5844	57	44.1 ± 0.5022	48	42.6 ± 0.3695
3 weeks	21	44.9 ± 0.4234	51	61.6 ± 0.7148	47	57.6 ± 0.5635	55	59.6 ± 0.6550	45	57.2 ± 0.6355
4 weeks	15	54.8 ± 0.4347	48	85.9 ± 1.5768	45	76.4 ± 1.0978	52	80.4 ± 1.0490	42	75.5 ± 0.7037
5 weeks	7	64.4 ± 0.5758	47	108.3 ± 1.7401	43	100.2 ± 1.3235	51	107.1 ± 1.5355	39	98.4 ± 1.3292
6 weeks	5	72.4 ± 0.6636	46	158.3 ± 2.9453	42	140.5 ± 1.8649	50	144.8 ± 2.8642	38	124.7 ± 1.5802
7 weeks	—	—	45	204.7 ± 5.3650	41	176.4 ± 2.5162	50	194.5 ± 3.8629	38	151.5 ± 2.1853
8 weeks	—	—	45	265.2 ± 6.4769	40	221.0 ± 3.5687	49	261.9 ± 4.8626	35	193.9 ± 3.3373
9 weeks	—	—	45	329.6 ± 7.9760	40	281.0 ± 4.5744	49	327.2 ± 6.1350	35	245.3 ± 4.4167
10 weeks	—	—	45	397.8 ± 9.3904	40	342.5 ± 4.6288	49	397.2 ± 6.0876	35	298.8 ± 6.5049
11 weeks	—	—	45	464.1 ± 9.4730	40	401.5 ± 5.4159	49	475.2 ± 7.4712	35	356.5 ± 6.8225
12 weeks	—	—	45	532.5 ± 10.3188	40	465.5 ± 6.5062	49	557.6 ± 8.5011	35	412.8 ± 7.0722

TABLE 2

Showing the percentage of mortality of the chicks up to the age of 12 weeks

LOT NO.	TRIALS			
	First	Second	Third	Av.
I	100.00	100.00	100.00	100.00
II	32.04	36.06	30.34	32.81
III	39.19	43.37	38.25	40.27
IV	27.24	28.79	24.52	26.85
V	46.66	50.59	46.04	47.76

TABLE 3

Showing the average amount and cost of feeds consumed by the chicks raised to the age of 12 weeks

ITEMS	LOT II (CORN MEAL)	LOT III (CORN BRAN)	LOT IV (CORN MEAL-RICE BRAN)	LOT V (CORN BRAN-RICE BRAN)
Total amount of feeds consumed	101.5 kgm.	85.7 kgm.	115.9 kgm.	76.4 kgm.
Amount of feeds charged per bird	2.256 kgm.	2.143 kgm.	2.337 kgm.	2.184 kgm.
Amount of feeds charged per 100 birds	225.6 kgm.	214.3 kgm.	236.7 kgm.	218.4 kgm.
Cost of feeds charged per bird	₱0.1328	₱0.1263	₱0.1251	₱0.1068
Total cost of feeds consumed	₱6.03	₱5.02	₱6.14	₱3.71
Cost of feeds charged per 100 birds	₱13.23	₱12.63	₱12.51	₱10.68
Amount of feeds necessary to make one kgm. live fowl	4.49 kgm.	4.90 kgm.	4.49 kgm.	5.66 kgm.
Cost of feeds required to make one kgm. live fowl	₱0.26	₱0.29	₱0.23	₱0.28
Efficiency of the mash ration based on amount of feeds required to make one kgm. live fowl	100.00	91.63	100.00	79.33

NOTES ON LOCUST MEAL AS A POULTRY FEED[1]

On June 4, 1935, a sample of locust meal weighing about one-half kilogram was received from the Bureau of Prisons, Manila. A small amount of this meal was sent to the Department of Agricultural Chemistry for analysis of its proximate nutrient contents, and the rest was used in a feeding trial, comparing it with fish meal ("Lighthouse" brand).

The sample of locust meal, as received, was finely ground, very light, and with a characteristic, but not disagreeable odor. The color was rich chocolate brown, with black particles scattered here and there. The sender of this sample did not state whether the meal was from hoppers or from fliers.

Analysis. The following table shows the proximate chemical analysis of the sample received.[2] The analysis of the fish meal used for comparison is also given.

NUTRIENTS	LOCUST MEAL	FISH MEAL
	per cent	*per cent*
Moisture	7.23	10.32
Fats (ether extract)	17.27	2.09
Ash	9.87	13.15
Proteins (N × 6.26)	30.72	64.88
Crude fiber	16.32	0.32
Carbohydrates (N.F.E.)	18.59	9.24
Calories per 100 grams	363.00	323.00

The figures in the tabulation show that the sample of locust meal received had a very much higher content of fats, crude fiber and carbohydrates than the fish meal used for comparison, but the amount of proteins in the locust meal is not quite one-half of that of the fish meal. The results of the chemical analysis of this meal indicate that locust meal may be profitably used as a source of protein supplement in the poultry ration. If the amount of locust meal, however, is increased to supply the optimum protein level needed by the particular flock that will be fed, the crude fiber content of the ration may be increased to an amount that may be beyond the capacity of the bird to take care of.

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[1] Experiment Station contribution No. 1062. Received for publication July 6, 1935.

[2] The help rendered by Mrs. Mamerta Manahan-Ylagan, Analyst of the Department of Agricultural Chemistry, is hereby acknowledged.

Feeding trial. As only a small quantity of locust meal was available for a feeding trial, only a few chicks could be fed and the test could cover only a short period. Two lots containing three chicks each were used in the test and the following all-mash rations were given to each lot:

INGREDIENTS USED	LOT 1 (LOCUST MEAL)	LOT 2 (FISH MEAL)
	parts	*parts*
Rice bran	56.25	56.25
Corn meal	18.75	18.75
Locust meal	25.00	.....
Fish meal	.....	25.00

The average weights of the chicks used in this trial are given in the following table:

DATE	LOT 1 (LOCUST MEAL)	LOT 2 (FISH MEAL)
1935	*grams*	*grams*
June 5 (Initial weight)	155.0	153.3
June 12	168.3	171.7
June 19	176.7	195.0
June 24 [a]	195.0	216.7 [b]

[a] The test could not be carried on any longer as the locust meal supply was exhausted.

[b] One of the chicks was sickly.

From these meager results, it may be seen that in feeding value, although locust meal can not compare favorably with fish meal in efficiency, it produced certain beneficial influences on the chicks. In addition to the 40.0 grams that the chicks in the locust meal lot, lot 1, gained in weight during the period covered by the test, these chicks remained healthy throughout. The fish meal lot made a gain of 63.4 grams during the same period. This increase in weight of the chicks in this lot, however, would have been larger had not one of the birds fallen ill. This particular chick decreased in weight from 200 grams on June 19 to only 195 grams on June 24 when the observations were closed.

Palatability. The chicks were observed to consume the ration containing locust meal just as eagerly as the fish meal ration. Although this may not be taken as a true measure of the palatability of locust meal, it indicates that when mixed with rice bran and corn meal in the proportion that was used in this trial, the chicks found the resulting mixture palatable.

Summary. From the limited observations made on the feeding value of locust meal, the following tentative conclusions may be drawn:

1. Basing judgment upon the chemical analysis of the sample of locust meal used in this trial, it may be stated that locust meal may be profitably used as a source of protein supplement in poultry rations.

2. If the amount of locust meal, however, is increased to supply the optimum protein level needed by the particular flock that will be fed, the crude fiber content of the ration may be so increased that it may be beyond the capacity of the bird to take care of.

3. Locust meal does not compare favorably with fish meal in efficiency, but it produced certain beneficial influences on the chicks.

4. The chicks were observed to consume the ration containing locust meal with just as good an appetite as they did the fish meal ration.

5. Further tests will be necessary before more conclusive statements can be made.

F. M. FRONDA
Of the Department of Animal Husbandry

ABSTRACTS [1]

The Jeswiet characters of sugar cane varieties in College of Agriculture cultures. LORETO V. VALERA. (*Thesis presented for graduation, 1932, with the degree of Bachelor of Science in Sugar Technology from the College of Agriculture No. 465; Experiment Station contribution No. 1059.*)—The object of this work was to study the so-called Jeswiet characters of sugar cane varieties in the College of Agriculture cultures.

Thirty-nine varieties of sugar cane were used in this study. Fifteen (6 thin type and 9 thick) were native and 24 (6 thin type and 18 thick) were foreign. The Jeswiet characters which refer to 71 hair groups distributed on the dorsal and ventral sides of the buds and of the leaf blades of sugar cane were carefully determined from each variety. Studies were made on the buds and leaf sheaths of plants having healthy stalks which were not less than six months old and had not as yet flowered. Buds that were still covered by the green leaf sheaths were examined. Twenty-five buds from each variety were examined. The buds were detached carefully from the cane stalk in order to avoid injury of the bud scales. Under the binocular microscope, the detached buds were examined for the presence or absence of the different hair groups. The first representative scale of the bud from each variety was drawn under the microscope. Size and shape of the typical buds of each variety were carefully considered. The leaf sheath and a part of the leaf blade of each variety were also examined for the presence or absence of the hair groups. The relative frequency of some hair groups found in both thin and thick types of sugar cane was also determined.

The buds of the different varieties were found to be round, oval, egg-shaped, inverted egg-shaped, and lozenge or diamond-like-form in shape. Even in the same variety, it was found that the shape of buds varied.

The author arrived at the following conclusions:

1. In no two varieties of sugar cane studied were all the Jeswiet characters the same.

2. The number of "constantly appearing" hair groups of any variety was greater than that of the "frequency appearing" and "rarely appearing" hair groups combined.

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[1] Abstracts prepared as part of required theme work in English 3a, College of Agriculture.

3. The hair groups found on the leaf sheath and part of the leaf blade were more constant than those found on the bud.

4. The occurrence of some hair groups in both the thin and the thick types of sugar cane tended to maintain a definite relationship. Some hair groups were more common in the thin type than in the thick type and the opposite was also true.

5. The hair groups of the thirty-nine varieties might differ as to position and extent and as to length and some special characteristics of the hairs.

6. As a result of this study, illustrations of the Jeswiet characters of thirty-nine varieties of sugar cane were drawn and filed in the Agronomy Department of this College.

—Abstract by Gregorio S. Chan

A preliminary study of simple marcottage as applied to cacao under field conditions. NICANOR S. BARTOLOME. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Agriculture, from the College of Agriculture, No. 466; Experiment Station contribution No. 1060.*)—Different methods of marcottage of cacao branches, *Theobroma cacao* Linn., were studied in order to determine the most feasible method of marcottage, the effect of different methods of treating the branches preparatory to marcottage, the approximate cost of marcottage under field conditions and the seasonal effects on the rooting of marcots. Nine hundred cacao marcots from young and old branches were used in this work. The three methods of marcottage were: (*a*) complete ringing of the bark, (*b*) partial ringing of the bark and (*c*) constriction method by the use of wire No. 9.

The results obtained by the author were summarized as follows:

1. From a practical viewpoint, successful propagation of cacao by the constriction method under field conditions is not possible.

2. Cacao marcottage by partial ringing of the bark may produce roots, but this method cannot be recommended since the roots produced were not enough to maintain the severed branch for further development.

3. Marcottage by complete ringing of the bark was the most successful of the three methods tried.

4. The best months found for marcotting the cacao tree in Los Baños were from July to December when there was abundance of rain.

5. The number of days required for the roots of cacao marcots to come out, and the percentage of rooting both in young and old branches were influenced by the monthly precipitation, number of rainy days and the presence of *Pachyrrhynchus chevrolati* Eyd. et Soul.

6. It took fewer days for the roots of both young and old branches to come out in partial ringing than in complete ringing of bark.

7. After the appearance of the roots through the wrapping materials of the marcots, they were ready for planting either in the pot or in the permanent field.

8. Young branches from 1.5 to 1.9 cm. in diameter were better for marcotting purposes than older branches 2.0 to 2.9 cm. in diameter.

—Abstract by Theodore G. Schuck.

CURRENT NOTES

A small ham curing and packing factory, financed and managed by Dr. Manuel L. Roxas, chairman of the National Research Council, is being set up in Lipa, Batangas, it is reported. According to Dr. Roxas the construction of the building to house the factory is almost completed and within two months production can be started. The plan calls for the manufacture of hams and sausages.

The Philippine Journal of Commerce, June, 1935

During May last year 329,477 people visited the Royal Botanic Gardens at Kew, May 21st, Whit Monday, leading with 73,644 visitors in a single day. The total for 1934 came to 1,170,369 of which 552,583 came during the week and 521,586 on Sundays. To these must be added 96,000 student visitors.

Tropical Life (London), June, 1935.

The production of coir which is so successful as a cottage industry on the Malabar Coast of India receives but little attention in Malaya. The little that is produced here is for the most part of poor quality, while more than 1,000 tons of coir and coir products valued at $170,000 are imported annually.

The Planter (F. M. S.), July, 1935.

Vernalization, or if you prefer it, jarovizacija, is a process new to agricultural science, largely a product of the active scientific research which is a feature of the Soviet regime in Russia. Already, although the underlying meaning of the process is not understood, it is being made practical use of in that country, and there seems a chance that, when the principles on which it is based are more fully understood, it may be given a wider application and may become of general value in other parts of the world. . . .

Vernalization is a process [treatment of seed] for accelerating the development of the flower and fruit in certain types of plants. . . The importance of the process to Russia may be gauged by the fact that in 1934 about 1 million hectares (approximately 2½ million acres) were sown with vernalized seed. *Agricultural Bulletin*, Bermuda, March, 1935.

Reprinted in *The Journal of the Jamaica Agricultural Society*, April, 1935.

The agricultural trade of Malaya is of four descriptions. In the first place, it is concerned with the preparation for market and export of agricultural products grown within its borders. The principal crops in this category are rubber, coconut products, pineapples, palm oil and kernels, tapioca, sago and arecanuts. Secondly, there is the trade, centred mainly in Singapore and Penang, which is concerned with the importation of agricultural products for consumption in Malaya. The chief crops of this description are rice, coffee, tea, groundnuts and oil, sugar, tobacco, livestock for food, meat, dairy produce, poultry and eggs. Thirdly, there is the trade, also centred largely in Singapore and Penang, which is concerned with the import of the agricultural produce to surrounding countries, its re-conditioning, blending and grading prior to distribution throughout the markets of the world. The most important crops included in this category are rubber, arecanuts, tapioca and sago, copra and various spices, condiments and essential oils. Lastly, there is the cultivation and marketing of Malayan crops within her own borders. Such crops include rice, coconut products, vegetables, fruit and poultry, and a large number of minor products.

The Malayan Agricultural Journal, April, 1935.

Reading ranks with travel and intercourse with one's fellow men as a means of acquiring knowledge, and for the rank of file of farmers is the most accessible. The average farmer is blessed with a fair amount of common sense, and has his own ideas about matters pertaining to his daily life. Left unexpressed, they are of small account. But passed on to his fellow men, the ideas become vitalised and of greater importance. . . .

The desire for and value of co-operative thought and action have been evidenced times without number. The danger of thinking and acting alone threatens to become political retrogression and industrial stagnation. The value of reading to the man on the land cannot be too greatly stressed. For, as he reads, so he thinks; and as he thinks, so does he act. . . .

The choice of literature is of very great importance. There are many dangers as well as benefits to be had from reading. It is well worth a man's while studying carefully the works of the day, before accepting all and sundry alike, and when Australia has a better informed farmer, who has the ability to put his "case," then, and then only, will she have a rural population who can defend the man on the land and lend a dignity to his calling.

Reading is one of the surest, safest, and most accessible means of acquiring a sense of expression, a knowledge of matters requiring understanding, and a real and lasting pleasure to the man on the land.

The Journal of the Department of Agriculture of South Australia, March, 1935.

COLLEGE AND ALUMNI NOTES

The Society for the Advancement of Research (SAR) on August 1 elected as associate members Mom Chao Chakrabandhu and Francisco R. Lopez, both members of the Class of 1936. Only senior students are eligible to associate membership in this honorary and scientific society. The basis on which they are selected is ability in scientific investigation as evidenced by their college work.

In the five years of the existence of SAR, fifteen seniors have been honored by being elected to associate membership.

The one-hundred-and-fourth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Plant Physiology Building, College of Agriculture in the evening of July 25, 1935.

The following papers were read and discussed:

"Observations on the effect of some storms on egg production"
By Dr. F. M. Fronda

"The development of Philippine agriculture during the American régime"
By Dr. B. M. Gonzalez

Mr. Walter Jepson, entomologist from Department of Agriculture, Mauritius, guest of the Club for the evening gave a most informative talk on Mauritius, its history, geography, and agricultural problems, especially those related to the principal crop, sugar.

On August 7, 1935 occurred a most important event, the first joint meeting on the Campus of the representatives of the Youth movement in China and the Philippines.

Ranking members of the Association of Chinese Youth and Filipino Youth held a Round Table conference with fifteen appointed student leaders in the College of Agriculture and fifteen from School of Forestry. Of the thirty students, three were Siamese and one Chinese. The conference which had for its purpose the devising of means and ways by which closer cultural relations between China and the Philippines could be attained was held from 10.00 a.m. to 12:00 noon in the College of Agriculture Library.

The conference was presided over by Teodoro G. Megia, president of the College of Agriculture Student Body. Mr. Teodoro Evangelista, president of the Filipino Youth, introduced the Chinese Youth members to the conference.

Mr. F. Y. Young, president of the Association of Chinese Youth, gave a vivid picture of the rôle being played by the Chinese Youth in the development of a New China. Among the topics presented and discussed was the sending of exchange students to China as a means of fostering closer cultural relations with that country. And the possibility of the formation of a Correspondence Committee.

After the conference, luncheon was served in Molawin Hall. Those present at the luncheon were: Messrs. F. Y. Young, Teodoro Evangelista, T. J. Kao, Stanley Ho, Lin Cheng Yung, Melchor Aquino, Jose Asprer, J. Alabastro, H. Pagulayan, Ocampo, Teodoro G. Megia, Rasuman Macalandong, Gabriel S. Flores, Felix Salcedo, Francisco Gomez, Crispin Dacanay, Demetrio Santos, Hilario Santos, Cornelio Macabasco, Romulo Gines, Flaviano Olivares, Francisco Lopez, Nelson Regalado, Mom Chao Chakrabandhu, Isidro C. Villa, Amando Dalisay, Teofilo Ancheta, Lauro Catapang, Lorenzo Zialcita, Dionisio Abella, Chan Min Sang, Cahu Kin, Tai Wai Kwan, Wong Tek Sau, So Tso Yum, Pang Kwock Kee, James Wong, Prudencio Martin, Moechtar Effendi Siregar, Guillermo Ponce, Daniel Lantion, Ernesto Tamayo, Teodorico Cepeda, José Rico, P. Lampoon, Vicente Gobuyan, Rufino Sabado, Domingo Madrid, Carlos Vargas, Augustine Springer, Santos Dueñas, Justino Ybañez, Timoteo Quimpo, and Artemio Genio. The young women College student guests were Misses Lee Pao Shan, Helen Au Yeung, Cheung Sui Fong, Chan Shauk Yee, Lourdes Dawis and Francisca S. Bandong.

Rasuman Macalandong, Vice President of the College of Agriculture Student Body as toastmaster at the luncheon introduced the following speakers: F. Y. Young, Teodoro G. Megia, Guillermo Ponce, and Teodoro Evangelista.

After the luncheon, the delegates visited the points of interest on the Los Baños Campus with representatives from the College of Agriculture and School of Forestry serving as guides.

At three o'clock in the afternoon there was a Campus convocation in the College of Agriculture Auditorium in honor of the Chinese and Filipino Youth delegates. Dean B. M. Gonzales, and Mr. Teodoro G. Megia spoke for the College of Agriculture, Mr. Teodoro Evangelista introduced the principal speaker, Mr. F. Y. Young. His theme was closer coöperation of the Chinese and Filipino Youth with aim of attaining close relations between China and the Philippines.

After the convocation, the Chinese and Filipino Youth Leaders were entertained at tea by Dean and Mrs. B. M. Gonzales at their residence on Faculty Hill.

Pio A. Tadina, a member of the senior class, was an active and successful worker in the illiteracy campaign last summer vacation. In his home barrio, Tanquigan, San Fernando, La Union, he taught a class of twenty-six, all adults, except three, for twelve hours a week for six weeks. At the close of the work each pupil was able to write his name and to read to some extent the newspaper—Ilocano dialect. The committee in charge of the campaign placed Mr. Tadina third among the successful workers, awarding him the ₱100 prize.

Miss Maxima Mulimbayan B. Agr. '35, a resident of San Antonio, a barrio of Los Baños, although she did not register for the work, sought out five illiterate residents of this barrio, two women and three men, and taught them during the summer vacation. She reports also that all five can now sign their names and read in Tagalog to some extent. She found these men and women pathetically eager to learn the printed word.

Miss Iluminada V. Torres '34 has the distinction of being the first woman in the Philippines to be appointed as teacher of agriculture. This statement is on the authority of Mr. Gilbert Perez, of the Bureau of Education. Miss Torres is on the teaching staff of Bilar Rural High School, Bohol. Miss Torres is teaching general science, biology, horticulture and animal husbandry. For recreation she coaches a basket ball team.

The Index for Volume XXIII, THE PHILIPPINE AGRICULTURIST is now ready for distribution. This index, as were the ones issued for the past several years, was prepared by Dr. G. O. Ocfemia.

The interest of the professor is to become unassailable, and so more authoritative. He achieves this by becoming more technical. For the more technical he gets, the fewer can comprehend him; the fewer are competent to criticize him, the more of an oracle he becomes. If therefore he wishes for an easy life of undisturbed academic leisure, the more he will indulge his natural tendency to become more technical as his knowledge grows, the more he will turn away from those aspects of his subject which have any practical or human interest. He will wrap himself in technical jargon and become as nearly as possible unintelligible. F. C. S. SCHILLER, *Tantalus*, 1924.

Science, January, 1935.

"Sense is better than sound. I am sending you a gift of books from London,"—was Benjamin Franklin's answer when asked to contribute a bell to a church.

There are reasons why more colleges have not ventured to break with tradition. One reason is fear of accrediting agencies. Another is the prevailing tendency of college faculties to consider every proposed change upon the basis of what is being done in other colleges, or from the standpoint of how the change will affect a particular department, instead of how it will affect the learning of youth. *The Daily Texan.*

Reprinted in *What The Colleges Are Doing*, May, 1935.

LIVE STOCK PRODUCTION AND TRADE IN LIVE STOCK PRODUCTS AS AFFECTED BY THE WORLD ECONOMIC CRISIS

(Summary of article by Stefan Taussig in *International Review of Agriculture*, July, 1934)

The point of departure of this inquiry was the question: Has the world economic crisis already brought about any decisive modifications in live stock production, and if so, of what nature?

From the evidence adduced it will be seen that the trade in live stock products has undergone very significant changes, whereas the live stock numbers, the basis of animal production, has suffered no decisive modifications due to the world crisis. The only noticeable modification affecting numbers has been seen to be the break down of the live stock economy of Soviet Russia. This modification, however, can scarcely be attributed to the world economic crisis, but is rather a consequence of internal events, peculiar to the U. S. S. R.

It is thus established that live stock farming, the branch of farming always showing the slower reaction to economic conditions, has been able to put up a good resistance to the unfavourable conditions, *viz.*, in part a decline in demand, but mainly a disastrous fall in prices for all live stock products.

It may even be said that the economic situation itself contributed towards checking any decline in live stock numbers, seeing that the conditions of the world meat market were certainly not such as to encourage slaughtering.

It has been shown that no decisive statistical modifications have occurred in respect of the numbers of the separate kinds of farm animals. A study of trade tendencies however shows that some modifications in the various branches of production have taken place.

It is clear that trade tendencies have very unfavourably affected the production of meat, and have favoured that of milk products, especially butter. Any comparison of the volume of these exports in the separate countries points to the conclusion that as regards cattle breeding meat production has been largely replaced by milk production.

In pig raising also there are noticeable changes, the production of pork and fat pigs having been largely replaced by the production of bacon pigs to meet the demand on the English markets.

The very frequently expressed view that reduced production would be found to be an effective remedy for the adverse conditions of the crisis now affecting society has, however, not been shared by all observers. There are some who have seen the best prospects for future improvement in a higher standard of general nutrition, and these persons will note with satisfaction that in the sphere of live stock breeding the tendencies to reduce production have not so far shown any striking results. Throughout the world, with the exception of the U. S. S. R., it is noted that the tendency is rather towards an increase in the productive stock of farm animals. Really heavy losses, endangering the production prospects for the future, are nowhere to be observed except in the U. S. S. R., so that on the whole the farm live stock production will, as heretofore, constitute the basis for meeting the requirements of an increased world consumption.

On the Post Office Building in Washington, D. C. the following inscription is carved.

This inscription was written by Woodrow Wilson and Charles W. Eliot.

MESSENGER OF SYMPATHY AND LOVE

SERVANT OF PARTED FRIENDS

CONSOLER OF THE LONELY

BOND OF THE SCATTERED FAMILY

ENLARGER OF THE COMMON LIFE

EFFECTS OF HEAT UPON THE VIABILITY OF BUÑGA (AEGINETIA INDICA LINN.) SEEDS[1]

R. B. ESPINO AND F. T. PANTALEON
Of the Department of Plant Physiology

WITH ONE TEXT FIGURE

This report forms a part of a series of experimental studies on *Aeginetia indica* Linn., a phanerogamic root parasite of the sugar cane plant, now being conducted by the writers, at the request of and in coöperation with the Calamba Sugar Estate.

Extensive studies on this parasite have been reported by several workers:—the principal ones being, the description of the parasite (Kusano, 1903, 1908-1909), extent of damage it does to the sugar cane plant (Roxas, 1927, 1931), and on germination of the seeds and early growth of the young plants (Kusano, 1903, 1908-1909). Some experiments intended to discover certain control measures have also been tried but not with much apparent success, (Teodoro, 1925; Agati and Tan, 1931a, 1931b). But literature on the effects of heat on the viability of the seeds of the parasite appears to be wanting—at least reports on experiments carried out under controlled conditions. Hence, this study was undertaken.

The main object of this study was to determine whether or not heat derived principally from burning straw could kill the buñga seeds or render them non-viable. As the study consisted of four sets of experiments or problems, the special object of each problem or experiment is given elsewhere.

This work was undertaken in the experimental plots of the Department of Plant Physiology. It was begun on January 3, 1934; the experimental data here presented were gathered on July 6, 1934, the experimental part thus covering a period of six months.

MATERIALS, METHODS AND RESULTS

The plants

Being a study on parasitism, two kinds of plants were employed, the host and the parasite. The host was the sugar cane plant, variety POJ 2878 or PSA 14; the parasite was *Aeginetia indica* Linn., locally

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[1] Experiment Station contribution, No. 1063. Received for publication August 5, 1935.

known as "buñga", "buñga ñg tubo", or "bulaklak ñg tubo". The host plants were started from seed cuttings furnished by the Calamba Sugar Estate; the parasite was started from seeds obtained from the same Sugar Central. To obtain good germination, the cane points were first soaked in water and allowed to root. When the roots were just starting to appear, the cane cuttings were planted in pots, one cutting of ordinary length to each pot. The seeds of the parasite were buried in or spread on the surface of the soil in the pots before the cane points were planted therein.

The culture media

Earthen pots sufficiently large to permit fairly normal development of the cane plants were used (fig. 1). They were filled with clay loam soil of medium fertility. Before placing it in pots, the soil was sifted and thoroughly mixed. Sixty-three pot cultures were used.

Pot cultures and results

As this study consisted of four problems, it is deemed advisable to describe separately the experimental procedures that were followed:

Problem 1. To determine the effects upon their viability when buñga seeds were exposed for different durations to a temperature of 100°C.

Samples of seeds of the parasite were placed in small paper boxes open at the top. The samples were placed in an electric oven with a temperature of 100°C. and kept there for different periods, ranging from 1 to 30 minutes. After this preliminary treatment the seeds were allowed to cool and were then spread on the surface of the soil in pots. Cane points, variety POJ 2878, were then pushed into the soil in the pots, dragging along with them whatever buñga seeds might be in the way, thus imitating in some measure the usual method of planting sugar cane points in the field.

This experiment was started on January 6, 1934 and consisted of seven cultures, each conducted in triplicate, as follows:

Culture I. With buñga seeds not heated.
" II. With buñga seeds heated in the oven for 1 minute.
" III. With buñga seeds heated for 4 minutes.
" IV. With buñga seeds heated for 10 minutes.
" V. With buñga seeds heated for 20 minutes.
" VI. With buñga seeds heated for 30 minutes.
" VII. Without buñga seeds, to test whether or not the soil used was originally free from the seeds of the parasite.

The cultures were examined daily for growth of the parasite and for other changes worth noting. Whenever necessary the cultures were weeded and watered. On July 6, 1934, the final observation of the cultures was made and experimental data showing the comparative degrees of infestation were gathered. No growth of the parasite was seen in culture VII, and one plant in each of the cultures III and VI was not infected. The data obtained from the triplicate cultures are given in table 1.

Problem 2. To determine the effects upon the viability of buñga seeds of pouring boiling water on soil and of burning rice straw on top of soil in pots.

This experiment was begun on January 9, 1934 and consisted of three cultures, each carried out in triplicate. The treatments given were as follows:

Culture I. Clay loam soil in pots to which buñga seeds were added.
" II. Clay loam soil in pots to which buñga seeds were added and then boiling water poured on the soil.
" III. Clay loam soil in pots to which buñga seeds were added and then rice straw burned on top of the soil.

The seeds of the parasite were spread on the surface of the soil in the pots, not buried. After the treatment of the soil with heat, seed cuttings of the sugar cane, variety PSA 14, were planted, one cutting to each pot. Whenever needed the cultures were watered and weeded, and on July 6, 1934, the cultures were finally observed for any growth of the parasite, and experimental data were gathered. The first visible growth of the parasite was noted on May 26, 1934, but the plants in culture I were apparently free from the parasite. One plant in each of the two remaining cultures was also apparently free from the parasite, but the other plants were attacked, as shown by the appearance of the flowers and flower buds of the parasite. The data obtained from the triplicate cultures are given in table 2.

Problem 3. To determine the effects of burning straw upon the the viability of buñga seeds buried in the soil at different depths.

This experiment was begun on January 3, 1934 and consisted of six pot cultures, each carried out in triplicate. Seeds of the parasite were buried in the soil at different depths (table 3), and a pile of rice straw was burned on top of soil in each pot. Then, cuttings of sugar cane ready to germinate were pushed down into the soil in pots, one cutting to each pot. On May 15, 1934, flower buds of the parasite began to appear and by July 6, 1934 all the cultures, excepting culture VI, had the flowers of the buñga. These were counted and the data obtained under each criterion of results were added together (table 3). The roots of the host plants in culture VI were dug up, cleaned and examined. No sign of infestation by the parasite was noted.

Problem 4. To determine germination of buñga seeds that might be mixed with buñga trash if this were heated or burned.

This experiment was to determine whether the buñga seeds that might be mixed with the buñga trash would be burned or killed, if the burning rice straw heated or set the buñga trash on fire. This experiment was begun on January 6, 1934 and consisted of five triplicate cultures. The buñga trash and capsules were placed on the surface of the pots, as described in table 4. On July 6, 1934, six months after planting, none of the cane plants in cultures I and V showed any flower or flower buds of the parasite. But, all the plants in cultures II and IV had reproductive structures of buñga; two out of the three cane plants in culture III, (a repetition of culture IV) failed to produce reproductive structures of the parasite even six months from the time of planting. The experimental data as obtained from the different triplicate cultures tried are given in table 4.

On July 9, 1934, the cane plants grown in all the pots that showed no sign of infestation by the parasite were dug up. Their roots were cleaned and examined. No sign of infestation was noted.

DISCUSSION OF RESULTS

In this study the viability of the seeds of *Aeginetia indica* Linn., a flowering plant and root parasite of the sugar cane plant, known locally as buñga, was reckoned, principally according to the number of the aërial parts. These were the flower buds, flowers and capsules that the parasite bore on July 6, 1934, six months from the time the experiments were begun. All the cultures that apparently had no aërial parts of the parasites were further investigated. The roots of the host plants were dug up, the soil carefully washed off with water, and then they were examined for any sign of parasitism. The results showed that buñga flower buds (still in the soil) were produced by one plant in each of the cultures II, IV and VI (table 1). The rest of the cultures that failed to send up aërial parts of the buñga plant were free from infection. The roots of the other cultures were not examined, because effects of parasitism were quite evident. The parasite was even able to produce reproductive structures, such as flower buds, open flowers, or capsules.

Buñga seeds resistant to heat

Table 1 shows that culture VII which was not inoculated with buñga seeds failed to produce any crop of flowers of the parasite. This fact seems to indicate that the soil was free from the parasite. Table 1 also shows that cultures II to VI inclusive produced reproductive structures of the parasite, plainly indicating that the sugar cane plants were infected and that the buñga seeds used were not all killed, if any were, by the heat, which was a temperature of 100°C. in an electric oven. Therefore, the seeds of *Aeginetia indica* Linn. are resistant to heat.

Buñga seeds in the soil not killed by heat from fire or boiling water

Table 2 shows that both cultures II and III had growths of the parasite. Boiling water was poured on the soil with buñga seeds in culture II and those in culture III were subjected to the heat from burning rice straw on top of soil in the pots. Therefore, when mixed with the soil, all the seeds of the parasite, if any, could not be killed by the heat from the burning straw or from boiling water.

Data in table 3 show that cultures I to V inclusive also had growths of the parasite. In these cultures the buñga seeds were in the soil in the pots at different depths, ranging from the surface to about 9 cm. below. The buñga seeds in these cultures were exposed to the heat from burning straw on top of soil and the growths of the parasite again show that not all, if any, of the buñga seeds could be killed by the heat from the burning straw. The absence of growth of the parasite in culture VI seems to indicate that the soil used was free from the seeds of the parasite because this culture (in triplicate), although not inoculated with the seeds of the parasite had the host plants.

Table 4 also shows the resistance of buñga seeds to heat from burning rice straw. Probably, the seeds that were clinging on buñga trash were destroyed by the fire or by the heat derived from it or rendered incapable of germination. This supposition was borne out by the fact that the cane plants in culture V were wholly free from the parasite infestation. In this culture, the seeds of the parasite were still in the capsules. When the straw was set on fire, the capsules were burned and probably the seeds also. Or, some of the seeds that might have been mixed with the buñga trash that was added to cultures II to IV may have fallen on the soil. The growth of the buñga plants in these cultures may have been due to the protection that the seeds received after reaching the soil. Therefore, once in the soil, the buñga seeds are difficult to destroy by heat or fire from burning straw.

Heat favorable to the germination of buñga seeds

Examination of the data in table 1 shows that heat seems to have favored germination of the seeds of the parasite. Culture IV, in which the seeds were exposed to a temperature of 100°C. for 10 minutes, produced the largest number of reproductive structures of the parasite, although cultures II and III, six months from the time of planting had produced the largest number of capsules, or ripe seeds. Each of these three cultures produced a heavier growth of the parasite than culture I, to which unheated seeds of the buñga were added. The data in table 1 also show that as the length of exposure to the temperature of 100°C. was increased from 1 to 10 minutes, a more luxuriant growth of the parasite was produced. Further lengthening the duration of exposure to the heat, however, seems to have decreased the power of the parasite to produce reproductive structures. The growth of the parasite resulting from the 30 minutes exposure to the heat was similar to the scanty growth of the parasite in culture I, in which the buñga seeds received no special treatment. From these observations, it is very evident that the exposure of buñga seeds to heat was favorable to their germination.

The data in table 2 also show the accelerating effects of heat upon the germination of buñga seeds and the subsequent growth of the plants. Culture I failed to produce any growth of the parasite although the buñga seeds used in this culture came from the same stock from which the seeds used in the other two cultures, II and III, were taken. These two cultures produced growths of the parasite. Culture II was treated with boiling water, and III with the burning of straw. Thus, the buñga seeds in the soil in these two cultures were subjected to artificial heating, and the result was germination of seeds and growth of buñga plants. It appears, therefore, that heat derived either from the boiling water or the burning of straw induced favorably germination of seeds of the parasites.

The data in table 4 also show the favorable influence of heat upon the germination of the buñga seeds. In this table it is shown again that culture I which received *untreated* buñga seeds failed to produce infestation, a result which seems to corroborate results already discussed. But, cultures III and IV were treated with the burning of straw and of buñga trash. Heat, therefore, was applied to these cultures, and the result was a better germination of seeds of the parasite than in culture I.

But, it may be asked, why should the growths of the parasite in these two cultures be less vigorous than in culture II? It may also be asked, why did culture V fail to produce infestation?

To properly answer these two questions, it should be recalled that the samples of buñga trash contained buñga seeds and were from the same stock. But, when the trash was burned, the seeds that may have been clinging on it may have been burned or rendered incapable of germination. Hence, fewer seeds were left to germinate in cultures III and IV. Moreover, when the buñga capsules were burned in culture V no growth of the parasite was obtained. The seeds in capsules must have been burned or their viability destroyed. Therefore, it may be concluded without doubt, that although buñga seeds in the capsules and on the trash were killed by heat, nevertheless heat favorably influenced the germination of the seeds of the parasite that were on top or in the soil.

Field practices in the light of present findings

It has thus been established experimentally, (*a*) that buñga seeds are resistant to heat; (*b*) that buñga seeds in the soil are not killed (at least not all) by the heat from fire or boiling water; and (*c*) that heat is favorable to the germination of the buñga seeds, when they are on the surface or in the soil. Therefore, the practice usually followed in cane fields of burning the trash will not exterminate the parasite. For, although burning may kill the seeds that are clinging on the trash or the seeds that are actually reached by the fire and thus subjected to the very intense heat, those that are in or mixed with the soil are scarcely injured. It is true, under field conditions, ripe seeds of the buñga are incidentally spread on the ground and are mixed with the soil during the harvest of the canes. These seeds are, therefore, placed under conditions favorable for escape of the harmful effects of the heat from the burning of cane trash. These seeds are also placed under conditions favorable to germination and the perpetuation and multiplication of the species. For these reasons, the experimental evidence here presented should remove any suspicion that the seeds of the parasite that succeeded in germinating in the field in which cane and buñga trash had been burned might have been brought there through the agency of wind, water, animals, or by men working in the field.

Kusano (1908-1909) reports that buñga seeds may remain viable for about two years; but he did not state whether the stock of seeds were kept in a bottle or were placed directly in the soil. In the series of experimental studies, of which this report is a part, the period of longevity of the seeds placed in moist soil is being studied [2]. So far, however, the cane plants in three of the monthly plantings have all been infected by the parasite. Hence, whether in the bottle or in the soil, the buñga seeds may remain viable for several months.

In the present study, it was found that the germination of the seeds was accelerated by heat or burning sugar cane trash in the field. A result [3] was also obtained that seems to indicate that the seeds (and not the underground parts of the parasite) are the means of infection of the roots of the cane plants. If this be true, to prevent further infection of the cane plants and to exterminate the parasite from the cane fields, the center of attack should be directed toward preventing the production of seeds and destroying those produced.

To test the truth of this assertion, experiments should be conducted. Before planting to sugar cane, the cane and buñga trash in a field heavily contaminated with buñga seeds should, as usual, be burned completely. By so doing, it is expected that the seeds of the parasite that are reached by the very intense heat will be destroyed. The heat from the burning trash would promote rapid germination of the buñga seeds that are in the soil and would accelerate the growth and development of the parasitic plants. It is expected that this rate of growth would be so rapid that by the end of about 124 days [4] from the time of burning the trash, when the cane plants are not yet very tall (fig. 1), the flower buds and flowers of the parasite would have begun to come out of the ground. To prevent the formation and spread of seeds in the field, these flowers and capsules should be occasionally picked off.

There is another aspect of this problem of ridding the cane field of buñga, the parasite should be prevented from ratooning. For, if allowed to ratoon it may produce seed, which apparently is the main, if not the sole, agent of infection. From casual observations and from careful studies made in sugar fields of the Calamba Sugar Estate, it was found that, "a constant development of fresh parasites appearing from the underground parts which remain fresh throughout the year" [5] was possible. It was also observed that, "all the buñga dug out and inspected in the field have been traced to emerge from the stools of the parasite which have managed to live and ratoon just like the cane plant". It follows that to be able to prevent the parasite from ratooning, the cane plants upon which it feeds should not be allowed to ratoon. Thus, it appears desirable that experiments be conducted in the field, so as to test the possible merit of *non-ratooning* as a control measure.

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[2] Experimental data on this point will be reported later.

[3, 4] Experimental data on these points, will be reported later.

[5] From the monthly report dated July 1, 1934 on observations of buñga made by Mr. Atanacio T. Carandang, Head, Research Department, Calamba Sugar Estate.

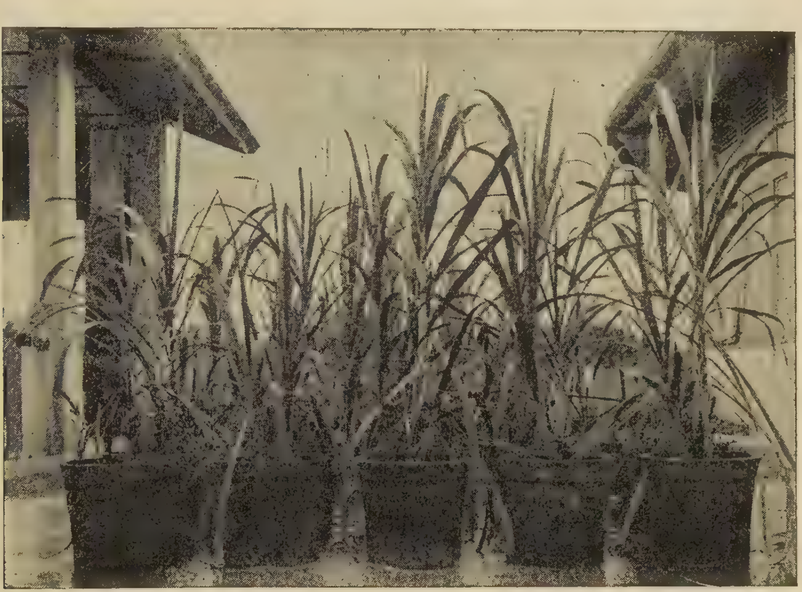

Fig. 1.—Sugar cane plants grown in pots heavily attacked by buñga (*Aeginetia indica* Linn.), a phanerogamic root parasite of the sugar cane. Note, in a culture, the flowers and capsules of buñga indicated by arrows. The other cultures were also heavily infested.

SUMMARY AND CONCLUSIONS

1. This report forms a part of a series of experimental studies on *Aeginetia indica* Linn., a phanerogamic root parasite of the sugar cane plant. Other reports will follow.
2. The seeds of buñga were found to be resistant to heat.
3. Once in or mixed with the soil, the buñga seeds were found to withstand heat from burning straw, or heat from boiling water.
4. Although buñga seeds in the capsules and those clinging on trash were killed by heat, nevertheless, when they were in the soil it was found that heat influenced favorably the germination of the seeds of this parasite.
5. Suggestions of certain tests that might be made in the field on the control or extermination of this parasite are given.

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TABLE 1

Showing effects upon viability of buñga seeds exposed for different durations to a temperature of 100°C.

CULTURE NO. AND DURATION OF EXPOSURE AT 100°C.	NUMBER OF FLOWER BUD CLUSTERS	NUMBER OF FLOWERS WITH VISIBLE STALKS	NUMBER OF OPEN FLOWERS	NUMBER OF CAPSULES
I. Not heated	2	17	0	0
II. 1 minute	9 + 2 [a]	43	15	10
III. 4 minutes	16	56	32	18
IV. 10 minutes	20 + 3 [a]	151	52	4
V. 20 minutes	16	49	18	6
VI. 30 minutes	5 + 2 [a]	10	3	0
VII. No seeds	0	0	0	0

[a] Buñga flower buds still buried in the soil. They were discovered when the roots of the cane plants were examined.

TABLE 2

Showing effects upon the viability of buñga seeds of pouring boiling water or burning rice straw on the soil

CULTURE NO. AND TREATMENT OF BUÑGA SEEDS	NUMBER OF FLOWER BUD CLUSTERS	NUMBER OF FLOWERS WITH VISIBLE STALKS	NUMBER OF OPEN FLOWERS	NUMBER OF CAPSULES
I. None [a]	0	0	0	0
II. With boiling water	2	9	3	3
III. With burning straw	8	33	0	0

[a] On July 9, 1934, the roots of the sugar cane plants in this culture were dug up, cleaned and examined. No infection by the parasite was found.

TABLE 3

Showing effects of burning straw on top of soil upon the viability of buñga seeds buried in the soil at different depths

CULTURE NO. AND TREATMENTS GIVEN	NUMBER OF FLOWER BUD CLUSTERS	NUMBER OF FLOWERS WITH VISIBLE STALKS	NUMBER OF OPEN FLOWERS	NUMBER OF CAPSULES
I. Buñga seeds on surface of soil, with burning [a]	37	203	29	0
II. Buñga seeds 3 cm. below surface of soil, with burning [a]	43	138	51	6
III. Buñga seeds 6 cm. below surface of soil, with burning [a]	37	150	21	22
IV. Buñga seeds 9 cm. below surface of soil, with burning [a]	15	64	35	17
V. Buñga seeds on surface and 3 cm. below surface of soil, with burning [a]	44	210	51	19
VI. No buñga seeds	0	0	0	0

[a] Dry cogon was burned on the surface of each pot.

TABLE 4

Showing germination of buñga seeds that might have been mixed with burning buñga trash

CULTURE NO. AND TREATMENT GIVEN [a]	NUMBER OF FLOWER BUD CLUSTERS	NUMBER OF FLOWERS WITH VISIBLE STALKS	NUMBER OF OPEN FLOWERS	NUMBER OF CAPSULES
I. No treatment	0	0	0	0
II. Buñga trash not burned	17	66	20	2
III. Buñga trash burned in pots	6	24	1	0
V. Buñga trash burned in pots	11	25	0	0
V. Buñga capsules burned in pots	0	0	0	0

[a] The burning of the buñga trash and of crushed capsules was facilitated by adding burning dry straw.

CO-OPERATIVE MARKETING AND OUR TOBACCO FARMERS [1]

PABLO N. MABBUN
Of the Department of Agricultural Economics

This paper is based on the results of studies on the co-operative marketing experience of the tobacco growers of Tuguegarao, Cagayan, and Ilagan, Isabela,[2] and of the tobacco growers in the state of Wisconsin, United States of America.[3] These studies are supplemented by observations made by the author of the operations of the "Land O' Lakes", a large co-operative marketing organization handling butter, in Minneapolis, Minnesota, coupled with information obtained from responsible officials of the working of the "California Fruit Growers' Exchange," an outstanding co-operative marketing association handling fruit in the state of California.

The results of these studies and observations suggest three questions: (1) Can co-operative marketing succeed among our Filipino tobacco growers? (2) If so, what plan of organization would best fit the level of intelligence, experience, and psychology of these farmers? (3) If co-operative marketing does not succeed would a government sales monopoly meet the conditions of the tobacco growers of the Islands?

TYPE OF CO-OPERATIVE ORGANIZATION NEEDED

What type of co-operative marketing organization may best fit the conditions in the tobacco region and the experience, intelligence and psychology of our tobacco growers? A little understanding of two popular and successful types of co-operative marketing organizations is necessary before an answer to this question can be given. These types are: (1) the federated type that is the basis of the plan of the California Fruit Growers' Exchange, and (2) the centralized type on which is based the plan of the Northern Wisconsin Co-opera-

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[1] Experiment Station contribution No. 1064. Received for publication July 8, 1935.

[2] PABLO N. MABBUN, Study of the Tobacco Growers' Association, Inc. of Tuguegarao, Cagayan. The Philippine Agriculturist 16: 19–33, 1927; also Progress of Tobacco Co-operative Marketing in Cagayan 16: 341–350.

[3] PABLO N. MABBUN, "A study of the Northern Wisconsin Co-operative Tobacco Pool: Possible application of the principles underlying its success to Philippine conditions. Thesis submitted for the degree of Master of Science at the University of Wisconsin, Madison, 1932. Unpublished.

tive Tobacco Pool. There are various modifications of these types of co-operative marketing organizations, but for the present purpose, the general set-up of the two types is sufficient.

It is generally accepted that the essential difference between these two types of co-operative marketing organizations is that in the centralized type it is absolutely necessary that all or a large part of any one crop or commodity shall be under the control of one organization, so that the movement of the crop or commodity to the market can be absolutely regulated and the price at which the product is sold can be arranged by bargaining between the organization acting as a unit and the buyers; whereas in the federated type, control more largely resides in the local co-operative unit, the central organization often merely acting as selling agent for the locals. The difference between the two types is therefore in the degree of centralization and control.[4]

A clearer idea of the differences between these two types of co-operative marketing organizations can be gained from a brief description of their respective plans of organization.

The California Fruit Growers' Exchange. This is a federation of 20 district exchanges.[5] The district exchanges are in turn federations of 218 local associations the membership of which includes about 10,500 citrus fruit growers. The organization is decentralized, the district exchanges having been created by the local associations and the California Fruit Growers' Exchange by the district exchanges. Authority is delegated, so to speak, from grower to local associations, from local associations to district exchanges and from district exchanges to the California Fruit Growers' Exchange. (See plan of organization of this type of association.)

The whole system is held together by a series of contracts. The grower signs a contract with the local association, from which he may withdraw by filing a notice with the secretary of the association during a specified period or before a certain date of any year. Most associations have five-year contracts, although a few contract for one year, and others for three years. A twenty-year contract, revokable at the end of any year upon notice, is made between the district exchanges and the locals. Each district exchange has a similar contract with the California Fruit Growers' Exchange.[6]

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[4] JOHN D. BLACK, AND H. B. PRICE, 1924, Co-operative Central Organization. University of Minnesota Experiment Station Bulletin 211, p. 16.

[5] BLACK AND PRICE give 20 district exchanges, but Senate Document 95, "Co-operative Marketing," U. S. Government Printing Office, Washington, D. C., 1928, p. 87–88 gives 25 district exchanges.

The California Fruit Growers' Exchange (1) establishes sales agencies in the principal cities and markets of the United States and Canada. These agencies are in charge of representatives who are directly responsible to the California Fruit Growers' Exchange. The Exchange, however, sells fruit only on confirmation of a district exchange or a local association. In practice, selling is no doubt left frequently to the central, but the local is nevertheless final authority in the matter. (2) It makes collections and transmits the proceeds to the shippers through a district exchange. (3) It prosecutes claims against railroad and car companies and handles all litigation growing out of the marketing of fruit. (4) It educates producers as to the best methods of production and preparation for market. (5) It advertises and develops new markets for citrus fruits. (6) It collects and disseminates market information, especially with respect to movement of citrus fruits. (7) It inspects cars enroute and at destination.

The functions of the district exchange are as follows: (1) To act as a clearing house for the local associations by disseminating the market information collected by the California Fruit Growers' Exchange. (2) To receive the returns for fruit through the central exchange and to return the proceeds to the locals. (3) To order cars for the local associations. (4) Where the exchange has received authority from a local association, to sell the fruit shipped by the local.

The local association sorts, packs and grades the fruit delivered by members. Many of them prune and fumigate the orchards and pick the fruit for members. Although the locals have authority to sell the fruit of their members, yet their experience has taught them that the district exchanges are in a better position than they to direct the movement of fruit to market and to determine when to sell, consequently, they have delegated this authority to the district exchanges. The identity of the fruit delivered at a local packing plant is maintained, however, and each association receives the returns from its own fruit. Each local has its own grade pools, although the length of the pool varies with the different associations and with the seasons. Occasionally, an association handles the fruit for each member individually. Most of the associations have their

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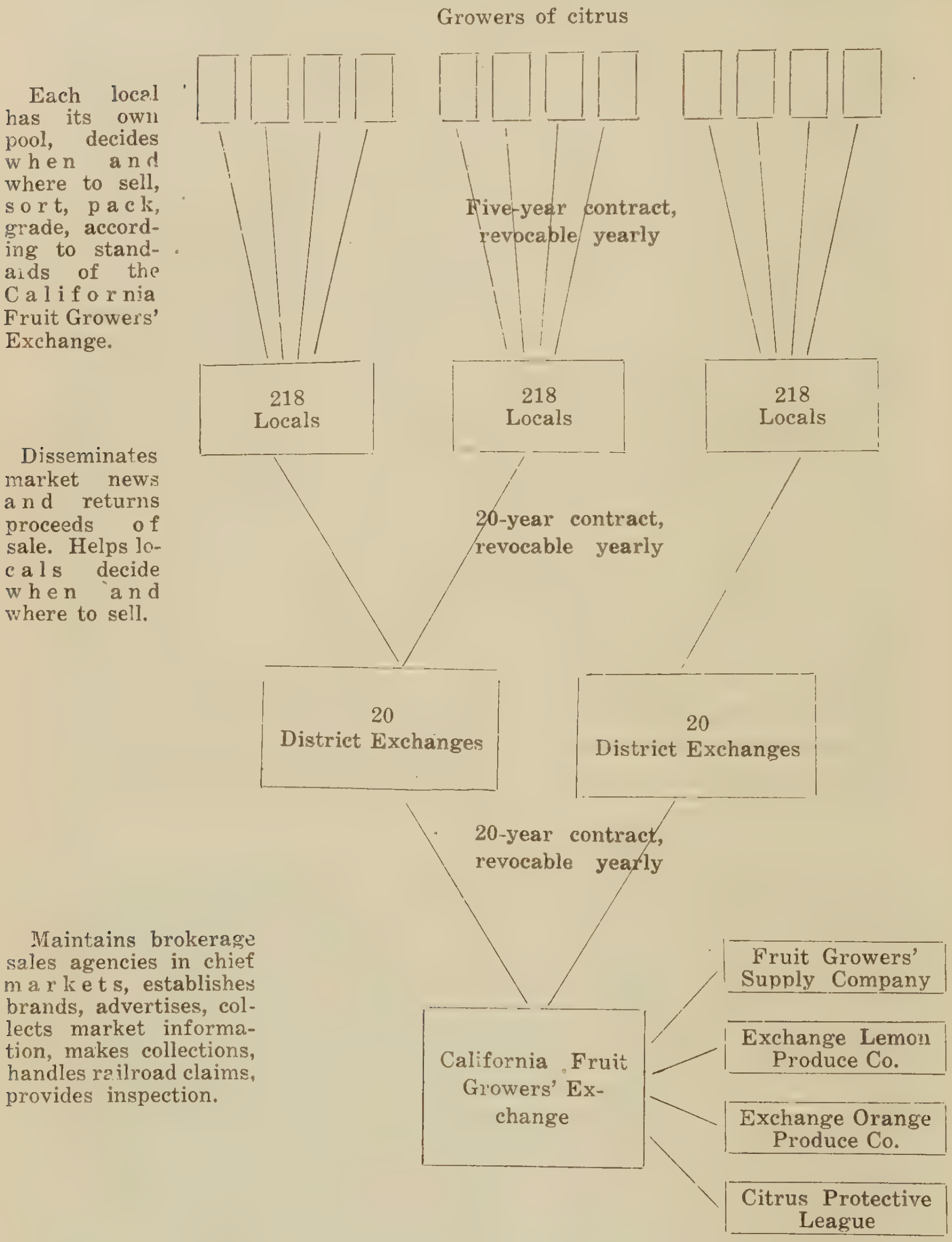
[6] Black and Price, Co-operative Central Organization, p. 17.

Organization of the California Fruit Growers' Exchange


Growers of citrus
Five-year contract, revocable yearly
218 Locals
218 Locals
218 Locals
20-year contract, revocable yearly
20 District Exchanges
20 District Exchanges
20-year contract, revocable yearly
California Fruit Growers' Exchange
Fruit Growers' Supply Company
Exchange Lemon Produce Co.
Exchange Orange Produce Co.
Citrus Protective League

Each local has its own pool, decides when and where to sell, sort, pack, grade, according to standards of the California Fruit Growers' Exchange.

Disseminates market news and returns proceeds of sale. Helps locals decide when and where to sell.

Maintains brokerage sales agencies in chief markets, establishes brands, advertises, collects market information, makes collections, handles railroad claims, provides inspection.

Copied in modified form from "*Co-operative Central Organization*," p. 17, by Black and Price.

own box labels. A large number of them also use the "Sunkist" and "Red Ball" brands, which are owned by the central organization, for their best grades. The local associations, however, may use these brands only when their fruits meet the specifications determined by the central exchange.[7]

Affiliated organizations are said to be rendering valuable service to the members of the Exchange. For instance, the Fruit Growers' Supply Company secures for them packing house and orchard supplies; the Exchange Lemon Products Company produces citric acid from lemons that cannot be marketed as fresh fruit; the Exchange Orange Products Company utilizes oranges that are not suitable for shipment; and the Citrus Protective League handles all the public policy questions that relate to the industry as a whole.[8]

The Northern Wisconsin Co-operative Tobacco Pool. This is a centralized organization of about 8,100 tobacco growers in the state of Wisconsin, United States of America. The authority rests in a board of 16 directors, elected by the members from the sixteen voting districts into which the association is divided. These districts have nothing to do with the business operations of the organization. They are established simply for the convenience of the members in voting. The directors hold office for one year or until their successors are elected and they elect their own officers, such as the president, treasurer, secretary and the manager. The policies and operations of the entire organization are drawn and directed by the board of directors. (See plan of organization of the Northern Wisconsin Co-operative Tobacco Pool).

The whole system is held together by a contract (marketing agreement) between each member and the organization, from which any member may withdraw by filing a notice with the secretary of the association during a specified period or before a certain date of any year, after the lapse of the first five years. In short, the centralized type of co-operative marketing organization may be considered as a local association working independently and performing all the functions assigned to the different branches in the case of the federated type. There are certain differences, however, in the policies and practices of the two types. In the following pages, I point out some of these differences and attempt to determine which

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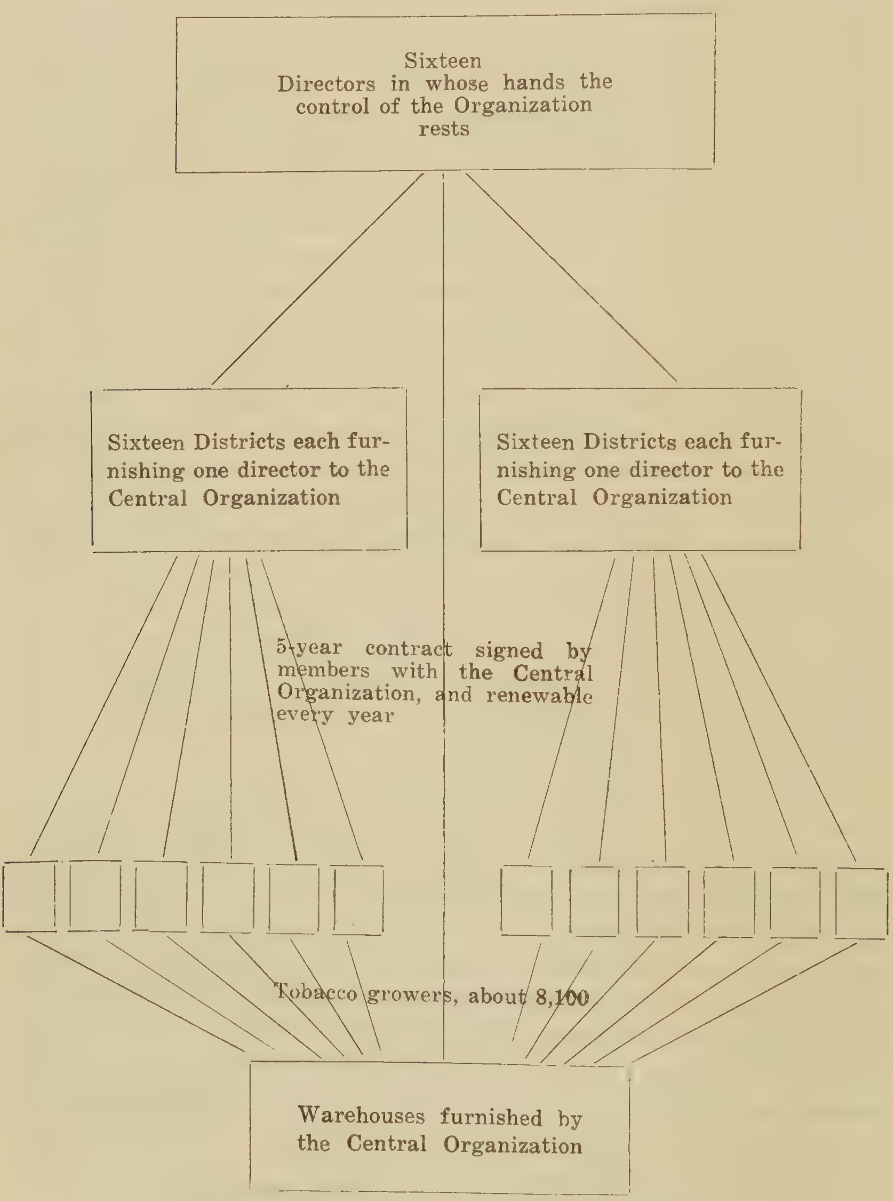
[7] BLACK AND PRICE, Co-operative Central Organization, p. 18.
[8] BLACK AND PRICE, Co-operative Central Organization, p. 18.

Organization of the Northern Wisconsin Co-operative Tobacco Pool


Sixteen Directors in whose hands the control of the Organization rests
Sixteen Districts each furnishing one director to the Central Organization
Sixteen Districts each furnishing one director to the Central Organization
5-year contract signed by members with the Central Organization, and renewable every year
Tobacco growers, about 8,100
Warehouses furnished by the Central Organization

points generally fit the conditions in the tobacco region in the Cagayan Valley and the intelligence, experience and psychology of the tobacco growers there.

CO-OPERATIVE MARKETING AMONG OUR TOBACCO FARMERS

Can co-operative marketing succeed among our Filipino tobacco growers? If properly directed, there are indications that it might succeed. That the co-operative movement is sponsored by the Bureau of Commerce and that laws favoring the co-operative marketing movement have been passed by the Philippine Legislature[9]; that there is a growing interest in this form of selling of tobacco are healthy hopeful signs. Moreover, the tobacco growers could be educated to appreciate the advantages of co-operative effort and led to perform successfully the fundamental practices of co-operative marketing organizations.

There are, however, certain conditions that tend to delay the progress of the co-operative marketing movement in this country. Let us examine how these conditions fit in the two types of co-operative marketing organizations described above.

The proportion of supply controlled by an association. With the centralized type of organization it is considered vital to its success that it control all or a large part of the supply of the commodity it handles; otherwise, the association is handicapped greatly in its collective bargaining and control of the flow of the produce to market. Although the federated type strives toward the same end, it does not consider this vital to its success. It is interested in control of produce because of the volume of business so necessary for economy in operation.

A centralized type of co-operative marketing organization would be handicapped in efforts to get even a large part of the tobacco produce in the Cagayan Valley owing to the absence of adequate banking facilities in the region where it could get credit, using the product as security. Our farmers are not favored by such excellent credit facilities, as the Intermediate Credit Banks, the Federal Land Banks, and other credit institutions, which take good care of the credit needs of the American farmers. This absence of adequate credit facilities also delays or makes impossible the building of warehouses adequate for the needs of the association. Although the Philippine Legislature has already passed laws authorizing the establishment of warehouses by municipalities,[10] not very much, if anything, has been done in the way of constructing these necessities in co-operative marketing.

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[9] See Act No. 3425 of the Philippine Legislature, approved December 9, 1927, providing for the organization of co-operative marketing associations. Also, Act No. 3895 of the same Legislature, approved November 16, 1931, authorizing the establishment of rural co-operative credit associations under the direction and control of the Philippine National Bank. Act No. 3896 of the same Legislature, approved November 16, 1931, authorizes the organization of rural banks to aid the farmers.

The strong influence of the few tobacco companies buying tobacco in the region,[11] coupled with the strong influence of individual money lenders who have liens on the tobacco crop of the farmers, limits the freedom of action of the tobacco growers in disposing of their product. These factors often make it difficult, if not impossible, for the Cagayan Valley tobacco growers to join or sign a marketing agreement with a co-operative marketing organization.

Under these conditions, the federated type of organization which can eventually be formed through joint action of independent local associations may have a better chance to succeed in that tobacco region. Local associations could be started either simultaneously or one after the other in places where the influence of money lenders is weak. The independent local associations should emphasize the value of joint action and endeavor to educate their members to understand the purposes, advantages and the business operations of a co-operative marketing organization. Efforts should also be directed toward making the powerful tobacco companies in the locality understand the purpose of the farmers' co-operative effort. The Government agent who is detailed to supervise the work of the co-operative marketing associations should act as counsellor and leader of the tobacco growers. To be able to do this wisely and with understanding, he should know the extent of the farmers' experience, the level of their intelligence and their psychology. This method might be a very slow process, but I see in it an eventual elimination of the usurious practices of individuals lending money to the farmers and the establishment of a more permanent co-operative system than that which is established with the idea of the lure of immediate profit. The strong faith of the farmers in Denmark and Switzerland in co-operation is due to their having been educated to understand why they co-operate, how they can successfully conduct the affairs of their co-operative organizations, and how important is the contribution of every one of them in the carrying out of the purposes of their co-operative effort.

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[10] Act No. 3929 of the Philippine Legislature, approved November 28, 1932, provides for the establishment of warehouses by municipal councils, and Act No. 3932, approved November 29, 1932 authorized the expenditure of two million pesos for warehouses and permanent bridges.

[11] PABLO N. MABBUN, 1927, Progress of Tobacco Co-operative Marketing in Cagayan, The Philippine Agriculturist 16: 341–350.

Price policy. The general practice of a centralized organization in naming the price of its product, which can, of course, be done effectively only when the organization has the bulk of the commodity in the region under its control, would be impossible in the Cagayan Valley tobacco region, for the same reason that this type of organization would not succeed there. On the other hand, the practice of the federated type in getting the actual market price can be effective by having the local association win the sympathy of the tobacco buyers. This type of organization has a fair chance to do this because it can show that it demands only the prevailing prices in the market. The centralized type, on the other hand, often relies on its bargaining power and tries to force the buyers to come to its terms. Difficulties have been met by the Tobacco Growers' Association Inc. of Tuguegarao, Cagayan owing to the efforts of its officers during its first years of operation to force the powerful companies in the locality to accept the prices they set for the association's product. The association, however, held only a very small portion of the total tobacco harvest in the locality.[12]

The control of quality of product. In the centralized type of organization absolute power is given to the association to determine the grades and classes and to rule out all produce that does not conform to specifications. This type of dictatorial guidance does not fit the psychology or the experience of the tobacco growers in the Cagayan Valley. They would have to learn gradually the advantages and need of such a power, otherwise they probably would sooner or later react unfavorably. But, a plan which would gradually introduce them to this centralization of power and lead them to understand the need for it would arouse their interest and make them eager to learn about it. Instances of this reaction of the tobacco growers were recorded during the period of the Tobacco Monopoly in the Cagayan Valley under Spanish administration. It is said that these tobacco growers raised a better quality of tobacco under the Monopoly than they are doing now. The compulsory nature of the Monopoly, however, coupled with the abuses of officials in its administration, caused the tobacco growers in the Cagayan Valley to rebel against the constituted authorities and finally the Monopoly was abolished.[13]

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[12] PABLO N. MABBUN, 1927, Study of the Tobacco Growers' Association, Inc. of Tuguegarao, Cagayan, The Philippine Agriculturist 16: 19.

Voting arrangements, the contractual arrangements and the membership status. In the federated type of organization the local association remains as a unit in the organization in the matter of voting, of selecting representatives and directors, of determining matters of major policy such as cannot be delegated to the board of directors, and also in the matter of contractual arrangement. In a federation the contracts are between the central organization and the locals, rather than between the members and the central. The members of the local association are the producers, and the local associations are members in the central organization. The local association is also usually the pooling unit, and to it is reserved some measure of control of the sorting and packing, time of selling, and even the market to which the product is shipped. All of these things, because of the size of the local unit, can be closely observed or easily understood by the tobacco grower and will help in the building up (from the bottom) of a co-operative marketing system which will be for the good of future generations, if it cannot give him all the benefits that he expects. This argument, of course, holds true only as long as the federated type retains the identity of the local associations, as far as control is concerned, for an organization may still be a federation even if it took all the forms of control named above out of the hands of the locals.

In contrast to this situation is the membership directly in the central organization, and contracts directly between the central and the member, and representation in the central organization on a district or some other basis. Thus, the local goes out of existence as a part of the organization, and all the functions performed as a part of a federation are performed by the central, with a single exception, the warehousing.

The direct membership in the centralized type of organization may meet the level of intelligence of our average tobacco grower, and perhaps also the warehousing plan, but the size of the unit organization makes it difficult for him to grasp the whole thing all at once. It would be something like asking him to solve a problem in algebra when he has had only grade one arithmetic. This lack of being able to grasp the working of the organization is one reason, probably the principal one, the members of the Tobacco Growers' Co-operative Marketing Association, Inc. of Tuguegarao, Cagayan could not understand the complex problems connected with the business operations of their association. This lack of understanding is why the Government agent, who acts as counsellor of the association, often takes into his hands the actual performance of certain activities which should properly be handled by officers of the association. Another unfortunate effect of not understanding more about the business problems of the association is that the members tend to become less loyal to their organization.

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[13] HUGO H. MILLER. 1932. *Principles of Economics Applied to the Philippines*, p. 302–304. Boston: Ginn and Company.

The use of the membership contract, the length of such contract, and the imposition of liquidated damages against offending members are just as important in a centralized as in a federated type of co-operative marketing organization. The use of the membership contract cannot be too strongly emphasized, especially in the case of an association the members of which may be composed of farmers who may be easy to lure away from their association because of inadequacy of understanding and appreciation of the purpose, advantages and complexity of the problems of co-operative marketing.

The length of the contract should be such that it gives the association a certain amount of stability. I think, for our tobacco growers', a five-year contract, revokable every year after the first five years, would be sufficient to get them to understand the working of a co-operative marketing organization and the intricate problems connected with its business operations.

The imposition of liquidated damages against members who violate the terms of their contract would be a constant reminder to the grower of his duty to his association and help keep him loyal to his organization, which is very necessary for the success of a co-operative business enterprise. These are some features which would be good for the co-operative marketing organizations among the tobacco growers in the Cagayan Valley.

GOVERNMENT SALES MONOPOLY

A Government sales monopoly would have very little chance of success, if it were possible to establish it, in the Cagayan Valley for reasons given elsewhere in this paper. Moreover, such a step would be contrary to the principles and practices of a democratic form of government. An attempt on the part of the Government to devote a large part of its funds and effort to the welfare of a class of farmers would be looked upon as class favoritism.

What the Government could do, however, under its guidance, would be to encourage these tobacco growers to establish a co-operative marketing system which would suit their temperament, understanding and business experience. A system that would educate them gradually to appreciate the advantages, purpose and complexity of the problems connected with co-operative effort is what our tobacco growers need. Such a type of organization may be found in the federated system, or some form of it modified to suit local conditions. The centralized type, or at least the application of some of its practices, has already been tried in the Cagayan Valley, particularly by the Tobacco Growers' Co-operative Marketing Association Inc. of Tuguegarao, Cagayan, but with little or no fruitful results.

SUMMARY

In this paper, I have tried to show that the hope of the tobacco growers in the Cagayan Valley is in the organization of local associations which would gradually teach the fundamentals of co-operative marketing and give practice in carrying them out. These locals could soon federate into municipal organizations and, in the course of time, into provincial and inter-provincial organizations,—that is, after the large majority or all of the farmers in the region have become members of local associations, they could form a central organization under some such plan as that of the California Fruit Growers' Exchange.

The building up from the bottom is essential, since I believe it is not so much the immediate profit from the system but its enduring strength that the growers should have. A co-operative marketing system built up, not so much from the incentive of making more money from crops immediately, as on the sound understanding and thorough knowledge of the human side of co-operation by those who own and control the system is what our tobacco growers, and for that matter all our farmers, need at present. This system seems to be satisfied by the federated type of co-operative organization, because the "program of the federation is democratic, proposing to accomplish the same ends as those aimed at by the centralized type, but carrying it out by leadership and education and incentive, leaving the members more free to follow instructions or not as they see fit, but having faith that if the central federation performs its part faithfully and well, the members will do the same; and its organization is built up on the basis of natural social and economic groupings."[14]

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[14] BLACK AND PRICE, 1924, Co-operative Central Organization, University of Minnesota Experiment Station Bulletin 211, p. 34.

The program of the centralized type, on the other hand, is fundamentally a legalistic one involving tying the growers firmly to a rigid, formal organization, set up frequently according to political divisions, with all the necessary provisions for compelling members to obey all the prescriptions.[15] Such a program might work for a short time, but the psychology and experience of our tobacco growers are strongly opposed to the compulsory part of the program.

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[15] *Ibid.*, p. 34.

THE EFFECT OF A 3-9-3 FERTILIZER MIXTURE ON THE GROWTH AND YIELD OF THE COTTON PLANT[1]

EULALIO P. BALTAZAR AND NAZARENO A. APELLIDO

INTRODUCTION

Increase in yield in cotton may be attained by the introduction of high yielding varieties, selection and breeding, better cultivation of the field and the proper use of fertilizers. The study reported in this paper was on the effect of fertilizers on the growth and yield of cotton in the Philippines. One important phase of such study is the rates of application of fertilizers or fertilizer mixtures on the plant to increase yield.

Review of literature

Jenkins (1919) suggested the following formula for average cotton soils. They may be modified as conditions vary: Nitrogen 3 per cent, phosphoric acid 6 to 8 per cent, and potash 3 per cent, to be applied at the rate of from 224.52 to 674.06 kilograms per hectare. He further recommended that when large quantities are used it is better to divide the amount into two equal parts and use it two times.

Williamson (1929) found that a ratio of 45.45 kilograms of nitrate of soda, 90.9 kilograms of phosphoric acid and 11.36 kilograms of muriate of potash was the proper proportion under the conditions of his experiment and when these fertilizers were combined in the above ratio and applied at the rates of 364.90 kilograms, 729.80 kilograms and 1094.63 kilograms per hectare, the greatest average profit came from the use of 729.78 kilograms per hectare.

Williams (1926) found that when the use of about 1,100.23 kilograms of a 7-3-2.5 fertilizer mixture is reached, the addition of larger amounts per hectare had a decreasing effect upon the percentage of total cotton bolls opened at the first picking.

Bartholomew and Jansen (1928) found that fertilizers increased the yield of cotton by increasing the number and size of bolls and the percentage of lint.

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[1] The greater part of the data in this paper was in a thesis prepared under the direction of the senior author and presented by the junior author for graduation, 1934, from the College of Agriculture with the degree of Bachelor of Science in Agriculture. Thesis No. 467; Experiment Station contribution No. 1065. This paper was revised by the senior author. Received for publication May 4, 1934.

Nelson (1932) found that for most sections of the state of Arkansas, the application of fertilizers at the rate of from 349.07 to 673.62 kilograms per hectare appeared to be most suitable. Under favorable conditions the rate of 673.62 kilograms per hectare gave the highest money returns and a percentage production of lint only slightly lower than that of 349.07 kilograms application. He further stated that no soil type locality or condition in Arkansas failed to respond satisfactorily to fertilizers used with cotton.

Burleson (1928) stated that the relative amounts of the three fertilizer elements in a fertilizer mixture are strong factors in determining the efficiency and value of fertilizers for cotton.

Objects and time and place of the present work

The objects of the present work were: (*a*) to study the effect of a 3-9-3 fertilizer mixture on the growth and yield of the cotton plant; and (*b*) to determine the rate of application per hectare of the fertilizer mixture best for growing cotton.

The work was performed in the Experiment Station grounds of the College of Agriculture, from June, 1933 to February, 1934.

MATERIALS AND METHODS

Variety of cotton used

The seed used was Batangas White variety and was obtained from the Bureau of Plant Industry at ₱0.40 a ganta. It gave a germination of 87 per cent.

Land preparation

A rectangular piece of land with an area of 1250 square meters and containing, according to Punzalan[2], 0.137 per cent nitrogen, 0.294 per cent phosphorus and 0.46 per cent potash was used in this study. The field had been planted to tobacco for two consecutive years before it was planted to cotton. The first plowing was early in June so as to bury and decompose the weeds in the soil. The second plowing and first harrowing were in the latter part of July. The third or final plowing was during the early part of August. The soil was thoroughly pulverized by harrowing the soil several times.

Division of plots

The field was divided into five lots which were arranged and numbered consecutively from I to V. Each lot was subdivided into

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[2] PUNZALAN, EDILBERTO S. The effect of fertilizers added to soil upon the yield of fiber and seed of cotton plant. An unpublished manuscript.

5 plots measuring 5 by 10 meters, covering an area of 50 square meters. In lot I, the plots were numbered from 1 to 5; lot II, 6 to 10; lot III, 11 to 15; lot IV, 16 to 20; and lot V, 21 to 25. (See diagram.)

Diagram showing arrangement of plots in the different lots in the experiment

LOT	PLOT				
I	1—Control	2—300 kgm.	3—400 kgm.	4—500 kgm.	5—600 kgm.
II	6—300 kgm.	7—400 kgm.	8—500 kgm.	9—600 kgm.	10—Control
III	11—400 kgm.	12—500 kgm.	13—600 kgm.	14—Control	15—300 kgm.
IV	16—500 kgm.	17—600 kgm.	18—Control	19—300 kgm.	20—400 kgm.
V	21—600 kgm.	22—Control	23—300 kgm.	24—400 kgm.	25—500 kgm.

Seeding

Four seeds were planted to a hill. The hills were distanced one meter each way. When the seedlings had attained a height of 10 centimeters above the ground, the weak ones were thinned out, leaving only the best plant in each hill.

Cultural operations

Weeding was done as often as necessary. A garden hoe was used in cultivating and in weeding the plants. Cultivation was shallow so as not to injure the surface roots of the plants.

Because it was rather dry in August and the plants were observed to be wilting, they were watered once.

Fertilizers used

The fertilizer mixture used in this study was compounded from ammonium sulfate as the source for nitrogen; single superphosphate for phosphorus; and potassium sulfate for potassium. According to the analysis of Menzi and Company, ammonium sulfate contains 20.6 per cent nitrogen, single superphosphate 18 to 20 per cent phosphoric acid and potassium sulfate 48 to 50 per cent potash.

The method used in computing the amount of fertilizers from the different sources, such as ammonium sulfate, single superphosphate and potassium sulfate for the different rates of application per hectare is shown as follows:

$$A = \frac{b \times c}{d} \times 100$$

Where A stands for the amount of fertilizer to be mixed; b for the rate of application per hectare; c for the ratio of the ingredient needed in making the mixture; and d for the percentage of the element in question as guaranteed by the company from which the fertilizers were obtained. Computing the ammonium sulfate, single superphosphate and potassium sulfate for the different rates of applications per hectare the amounts are:

For 300 kilograms treatment:
For ammonium sulfate,

$$A = \frac{300 \times 0.03}{20.6} \times 100 = 43.69 \text{ kgm.}$$

For single superphosphate,

$$A = \frac{300 \times 0.09}{19.00} \times 100 = 142.10 \text{ kgm.}$$

For potassium sulfate,

$$A = \frac{300 \times 0.03}{49.00} \times 100 = 18.37 \text{ kgm.}$$

The same formula and method were used in computing the amounts of fertilizers needed to compound 400, 500 and 600 kilograms mixtures per hectare.

In computing the amount of the different ingredients to be mixed in the fertilizer formula (3-9-3) to be used for the actual area fertilized under the different rates of application, a second formula was used,

$$A = \frac{\dfrac{b \times c}{d} \times 100}{10{,}000} \times M$$

Where A stands for the amount of fertilizer needed for the area in question; b for the rate of application per hectare; c for the ratio of the ingredient needed in making the mixture; d for the percentage of the element as guaranteed by the company; 100 for 100 per cent, pure chemical analysis; 10,000 for the number of square meters in a hectare and M for the area to be fertilized.

Computing the fertilizer ingredients actually needed for the required area at the rate of 300 kilograms per hectare, the amounts are:

For ammonium sulfate:

$$A = \frac{\dfrac{300 \times 0.03}{20.6} \times 100}{10{,}000} \times 250 = 1.09 \text{ kilograms}$$

For superphosphate:

$$A = \frac{\dfrac{300 \times 0.09}{19} \times 100}{10{,}000} \times 250 = 3.55 \text{ kilograms}$$

For potassium sulfate:

$$A = \frac{\dfrac{300 \times 0.03}{49} \times 100}{10{,}000} \times 250 = 0.46 \text{ kilograms}$$

Similar computations were made for 400, 500 and 600 kilograms treatments. The following table shows the amounts of the different ingredients of fertilizers used for given areas in this study and per hectare.

KIND OF FERTILIZER	ANALYSIS	AMOUNT OF FERTILIZERS USED IN THE DIFFERENT RATES OF APPLICATION							
		300 kgm. application		400 kgm. application		500 kgm. application		600 kgm. application	
		For area	Per hectare	For area	Per hectare	For area	Per hectare	For area	Per hectare
		kgm.	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*	*kgm.*
Ammonium sulfate	20.60 N	109	43.69	1.46	58.25	1.81	72.81	2.18	87.33
Single superphosphate ...	19.00 P_2O_5	3.55	142.10	4.74	189.47	5.92	236.84	7.11	284.21
Potassium sulfate	49.00 K_2O	0.46	18.37	0.61	24.49	0.77	30.61	0.92	36.73

Method of fertilizer application

Just before planting, one-half of the fertilizer mixture in each treatment was uniformly broadcast and thoroughly mixed with the soil in the plots. The remaining half was applied as top-dressing around the plants when they were 30 days old. The amount of fertilizer given each plant was measured with a bamboo cup.

The diagram given elsewhere in this paper shows the arrangement of plots used. It shows that each lot had one control. Each plot in each lot received different rates of application. Lot I, plot 2, received an application of 300 kilograms per hectare; plot 3, 400 kilograms; plot 4, 500 kilograms; plot 5, 600 kilograms; and plot 1 served as control.

Lot II, plot 6 received an application of 300 kilograms per hectare; plot 7, 400 kilograms; plot 8, 500 kilograms; plot 9, 600 kilograms; and plot 10 served as control.

Lot III, plot 11 received an application of 400 kilograms per hectare; plot 12, 500 kilograms; plot 13, 600 kilograms; plot 14 served as control; and plot 15, 300 kilograms.

Lot IV, plot 16 received an application of 500 kilograms per hectare; plot 17, 600 kilograms; plot 18, served as control; plot 19, 300 kilograms; and plot 20, 400 kilograms.

Lot V, plot 21 received an application of 600 kilograms per hectare; plot 22, served as control; plot 23, 300 kilograms; plot 24, 400 kilograms; and plot 25, 500 kilograms.

Characters studied

In this work, the following characters were studied; growth, when the squares first appeared, first blooming, first appearance of bolls, maturity of first opened bolls, size of bolls, and yield of fiber under different treatments.

Growth. Ten plants picked at random from each plot, making 50 in all for 5 plots, were used for each treatment. Records on the mode of growth of these plants were taken during the last picking and were recorded under the following headings: height, lateral expansion, type of growth.

(*1*) *Height.* With the use of a meter stick the height of the plants was measured from the ground up to the tips of their terminal buds.

(*2*) *Lateral expansion.* With the meter stick the lateral expansion of the plants was measured at the widest portion of the crowns.

(*3*) *Types of growth.* The types of growth of the plants were listed under six categories, such as lopsided; pyramidal; cylindrical; two stories; forked and open center.

Appearance of squares, first bloom, boll formation and boll maturity. The plants were visited every day so as to be able to know the exact date of the appearance of the first squares on plants grown under the different treatments; the appearance of the first blooms; formation of bolls; and the maturity of bolls.

Size of bolls. The length and diameter of forty bolls taken from each plot were measured when they were about 30 days old. This was done to determine the effect of the different rates of application of fertilizers on the size of bolls produced in the different plots. Harvesting was done as often as the bolls opened in the field. The harvests obtained from the different lots and plots were kept separate.

Determination of yield of fiber. The lint from the bolls produced under the different treatments was ginned so as to separate the seeds from it. Then the weight of the lint, the seeds and the capsules were taken separately to determine the production of lint and the percentage of lint.

RESULTS

The results of this experiment are presented in tables 1 to 10.

Table 1 shows the mean height and lateral expansion of the crown of fifty plants picked at random under each treatment (during the last picking).

Table 2 shows the data on the types of growth of fifty representative plants picked at random under the different treatments.

Table 3 shows the data on the growing period required for blooming and fruiting of cotton plants as affected by a 3-9-3 fertilizer mixture.

Table 4 shows the mean length and diameter of bolls under each treatment.

Table 5 shows the data on the yields of the different plots as affected by different rates of application of 3-9-3 fertilizer mixture.

Table 6 presents the percentage and average yield per plot under different treatments.

Table 7 presents the data on the yield of each plot and the computed yield per hectare.

Table 8 gives the comparison of the different treatments in the mean yields of lint per hectare.

Table 9 gives a summary of the results shown in table 7 and shows the money value of mean yields per hectare in the different treatments.

Table 10 shows the relative returns from the use of 3-9-3 fertilizer mixture.

DISCUSSION OF RESULTS

Table 1 clearly shows that the mean height of the plants grown under different treatments varied a great deal, the mean height of the control being 125.12 ± 1.44 centimeters; 300 kilograms treatment, 137.55 ± 1.64 centimeters; 400 kilograms treatment, 148.85 ± 1.24 centimeters; 500 kilograms treatment, 146.98 ± 2.27 centimeters and 600 kilograms treatment, 128.01 ± 3.77 centimeters. It may also be seen that the plants which served as control averaged shorter than those which were fertilized. The plants that received 400 kilograms treatment were the tallest.

Likewise the plants which did not receive any fertilizer application made less growth in lateral expansion than the plants which received fertilizer treatments.

It is shown in table 2 that all of the plants picked for this particular phase of the work exhibited different types of growth in all the treatments including the control. The most common was pyramidal in form and the least common was lopsided.

It may be seen in table 3 that the squares of the untreated plants appeared within 40 days from the date of planting and those of the fertilized plants within 38 days. The plants treated with 400 kilograms per hectare flowered the earliest. The untreated plants took the longest time to flower, which was 67 days from the date of planting. It is interesting to note that though the untreated plants took a longer time to produce squares and blooms than the fertilized plants, they required a shorter time to mature bolls.

Table 4 presents the mean length of the bolls of the cotton plants under each treatment. It may be clearly seen in this table that the bolls produced by the untreated plants were shorter than those produced by the treated ones. The mean length of the bolls under the different treatments were: 4.95 ± 0.010 centimeters for control; 5.04 ± 0.008 for 300 kilograms treatment; 5.05 ± 0.010 for 400 kilograms treatment; 5.00 ± 0.009 for 500 kilograms treatment, and 5.03 ± 0.014 for 600 kilograms treatment. The mean diameter of the bolls under the different treatments were: 2.98 ± 0.008 centimeters for control; 3.05 ± 0.008 for 300 kilograms; 3.07 ± 0.008 for 400 kilograms; 3.07 ± 0.009 for 500 kilograms treatment and 3.19 ± 0.043 centimeters for the 600 kilograms treatment.

In table 5 are presented the data on the yields of different plots as affected by different rates of application of the 3-9-3 fertilizer mixture. It may be seen in this table that the unfertilized plots (1, 10, 14, 18, and 22) gave the lowest yield in actual number of bolls produced and also in actual weights of capsules, seeds and lint. The plots which received 400 kilograms treatment (3, 7, 22, 24) produced the largest number of bolls, and also greatest weight of capsules, seeds and lint. The difference in yield as exhibited by the different plants was undoubtedly due to the effect of different quantities of fertilizer applied in the soil.

Table 6 shows the percentage and average yield per plot under different treatments. It is evident from this table that the untreated plants produced the least number of bolls; which was 334.40 with a corresponding weight of lint of 0.360 kilogram, while those of the treated plots produced a larger number of bolls. The 300 kilograms treatment produced 612.4 bolls; with a corresponding weight of lint of 0.76 kilogram; the 400 kilograms treatment produced 971.20 bolls with a corresponding weight of lint of 1.061 kilograms, the 500 kilograms treatment produced 711 bolls with a corresponding weight of lint of 0.886 kilogram; and the 600 kilograms treatment, 671.40 bolls with a corresponding weight of lint of 0.734 kilogram. The difference in yield was undoubtedly due to the effect of the varying amounts of fertilizer added in the soil.

Table 7 gives the actual yield in lint of each plot and the computed yield per hectare. It is likewise shown in this table that the untreated plants produced the least amount of lint. Basing the computation of the yield per hectare on the actual yield of lint produced under each treatment it is found that the untreated plants produced less lint than the treated ones.

Table 8 shows the comparison among the different treatments in their mean yields of lint per hectare. It is obvious from this table that the difference in yield among the different plots compared is greatest in 400 kilograms versus control which was 143.56 ± 18.62 kilograms, and least in 300 kilograms versus 600 kilograms treatment which was 5.62 ± 11.98 kilograms.

Table 9 shows the money value of the mean yields of lint per hectare of the different treatments. Using the actual yield of lint obtained from different treatments it may be seen that the untreated plants produced 71.96 ± 7.90 kilograms per hectare; 300 kilograms treatment, 153.04 ± 7.49 kilograms; 400 kilograms treatment, 215.52 ± 16.86; 500 kilograms treatment, 165.60 ± 6.83 kilograms; and 600 kilograms 147.40 ± 9.53 kilograms. At ₱0.17 a kilogram the corresponding values of lint produced per hectare from the different treatments were ₱12.23, ₱26.02, ₱36.64, ₱28.15, and ₱27.41.

Table 10 presents the relative returns from the use of a 3-9-3 fertilizer mixture. It may be seen in this table that in all cases the 3-9-3 fertilizer mixture gave a greater production of cotton than the control. Although an increase was obtained in all cases, the proportional return was not the same in each case, as the net gain of ₱1.20 per hectare was realized from the treatment with 300 kilograms and of ₱8.40 with 400 kilograms; the loss of ₱4.71 per hectare was incurred from the treatment with 500 kilograms, and of ₱12.35 with 600 kilograms.

SUMMARY AND CONCLUSIONS

1. The fertilizer used in this study was home-mixed containing 3 per cent nitrogen, 9 per cent phosphoric acid and 3 per cent potash.

The sources for nitrogen, phosphoric acid and potash were ammonium sulfate, single superphosphate, and potassium sulfate, respectively.

2. Fertilized plants were taller than those of the control but the plants treated with the 400 kilograms per hectare were the tallest.

3. The average diameter of the crown of the control plants was less than that of those plants which received different rates of fertilizer application.

4. The plants in all the treatments including the control exhibited different types of growth, the most common was pyramidal, and the fewest were lopsided in types.

5. The fertilized plants produced squares and bloomed earlier than the untreated ones, but the bolls produced by the unfertilized plants opened earlier than those of the treated ones.

6. The bolls produced by the control plants were shorter in diameter than those of the fertilized plants.

7. Those plants which received 400 kilograms per hectare produced the largest number of bolls and also the greatest weight of capsules, seeds and lint; the unfertilized plants had the least yield.

8. In all cases the 3-9-3 fertilizer mixture increased the production of cotton, but the proportional return was not the same in every case, as net gains of ₱1.20 and ₱8.45 per hectare were realized from the treatments with 300 and 400 kilograms, respectively; and losses of ₱4.71 and ₱12.34 were incurred from the treatments with 500 and 600 kilograms, respectively.

9. The most profitable rate of application was found to be the 400 kilograms treatment per hectare.

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TABLE 1

Mean height and lateral expansion of the crown of fifty cotton plants selected at random under each treatment (during the last picking)

TREATMENT PER HECTARE	NUMBER OF PLANTS MEASURED	MEAN HEIGHT	STANDARD DEVIATION	COEFFICIENT OF VARIABILITY	MEAN LATERAL EXPANSION	STANDARD DEVIATION	COEFFICIENT OF VARIABILITY
kgm.		*cm.*	*cm.*	*per cent*	*cm.*	*cm.*	*per cent*
Control	50	125.12 ± 1.44	15.12	30.24	119.10 ± 1.28	13.44	26.88
300	50	137.55 ± 1.64	17.20	34.40	134.42 ± 1.73	18.13	36.26
400	50	148.85 ± 1.24	13.01	26.02	141.28 ± 1.35	14.24	28.58
500	50	146.98 ± 2.27	23.84	47.68	138.12 ± 1.17	12.36	24.72
600	50	128.01 ± 3.77	39.54	79.80	129.85 ± 0.79	8.36	16.72

TABLE 2

Types of growth of fifty representative plants picked at random under different treatments

TREATMENT PER HECTARE	NUMBER OF PLANTS	TYPES OF GROWTH					
		Lopsided	Pyramidal	Cylindrical	Two stories	Forked	Open center
kgm.							
Control	50	6	19	8	5	5	7
300	50	7	15	6	5	7	10
400	50	3	17	10	5	7	8
500	50	5	19	6	8	6	6
600	50	6	20	5	4	9	6

TABLE 3

Growing period requirement for blooming and fruiting of cotton as affected by a 3-9-3 fertilizer mixture

TREATMENT PER HECTARE	NUMBER OF DAYS FROM PLANTING TO		
	First square	First bloom	First open boll
kgm.	*days*	*days*	*days*
Control	40	67	120
300	38	64	121
400	37	61	122
500	38	62	122
600	38	62	122

TABLE 4

Mean length and diameter of bolls of cotton plants under each treatment

TREATMENT PER HECTARE	NUMBER OF BOLLS MEASURED	MEAN LENGTH	STANDARD DEVIATION	COEFFICIENT OF VARIABILITY	MEAN DIAMETER	STANDARD DEVIATION	COEFFICIENT OF VARIABILITY
kgm.		*cm.*	*cm.*	*per cent*	*cm.*	*cm.*	*per cent*
Control	200	4.95 ± 0.010	0.23	0.11	2.98 ± 0.008	0.17	0.04
300	200	5.04 ± 0.008	0.15	0.15	3.05 ± 0.008	0.18	0.09
400	200	5.05 ± 0.010	0.20	0.10	3.07 ± 0.008	0.16	0.08
500	200	5.00 ± 0.009	0.19	0.10	3.07 ± 0.009	0.18	0.09
600	200	5.03 ± 0.014	0.31	0.15	3.19 ± 0.043	0.92	0.46

TABLE 5

Yield of different plots as affected by different rates of application of a 3-9-3 fertilizer mixture

PLOT NO.	AREA	AM'T. FERTILIZER USED	AM'T. FERTILIZER USED PER HA.	YIELD OF EACH PLOT				
				Bolls		Weight of capsules	Weight of seeds	Weight of lint
				Number	Weight			
	sq. m.	*kgm.*	*kgm.*		*kgm.*	*kgm.*	*kgm.*	*kgm.*
1	50	—	—	418	2.296	0.732	1.128	0.436
10	50	—	—	290	2.096	0.549	1.119	0.428
14	50	—	—	430	1.748	0.510	0.790	0.448
18	50	—	—	258	1.172	0.440	0.522	0.210
22	50	—	—	278	1.294	0.527	0.489	0.278
2	50	1.5	300	750	4.326	1.267	2.102	0.907
6	50	1.5	300	662	4.080	1.148	2.101	0.831
15	50	1.5	300	678	3.801	1.117	1.804	0.880
19	50	1.5	300	550	3.776	1.087	1.984	0.705
23	50	1.5	300	442	2.661	0.803	1.347	0.511
3	50	2.0	400	600	3.153	1.042	1.466	0.655
7	50	2.0	400	1002	5.437	1.651	2.598	1.188
11	50	2.0	400	1192	5.916	2.079	2.463	1.374
20	50	2.0	400	1126	6.393	1.819	3.245	1.329
24	50	2.0	400	936	4.860	1.537	2.465	0.858
4	50	2.5	500	841	4.795	1.351	2.494	0.950
8	50	2.5	500	577	3.383	1.016	1.636	0.711
12	50	2.5	500	691	3.660	1.096	1.741	0.823
16	50	2.5	500	637	3.873	1.149	1.924	0.800
25	50	2.5	500	809	4.825	1.397	2.379	1.049
5	50	3.0	600	833	5.068	1.507	2.620	1.941
9	50	3.0	600	712	3.782	1.252	1.707	0.823
13	50	3.0	600	515	3.112	1.103	1.386	0.623
17	50	3.0	600	432	2.749	0.871	1.314	0.564
21	50	3.0	600	585	3.547	1.032	1.796	0.719

TABLE 6

Percentage and average yield per plot under different treatments

TREATMENT PER HECTARE	AVERAGE YIELD PER PLOT							
	Bolls		Capsules		Seeds		Lint	
	Number	Weight	Weight	Percentage	Weight	Percentage	Weight	Percentage
kgm.		*kgm.*	*kgm.*	*per cent*	*kgm.*	*per cent*	*kgm*	*per cent*
Control	334.4	1.722	0.552	32.06	0.810	47.04	0.360	20.90
300	612.4	3.134	1.084	29.18	1.868	50.38	0.761	20.44
400	971.2	5.134	1.626	31.66	2.447	47.67	1.061	20.67
500	711.0	4.102	1.202	29.15	2.035	48.89	0.886	21.96
600	671.4	3.653	1.153	31.57	1.766	48.31	0.734	20.12

TABLE 7

Actual yield in lint of each plot and the computed yield per hectare

PLOT NO.	TREATMENT	WEIGHT OF LINT	COMPUTED YIELD PER HECTARE
		kgm.	*kgm.*
1	Control	0.436	87.20
10	”	0.428	85.60
14	”	0.448	89.60
18	”	0.210	42.00
22	”	0.278	55.60
2	300 kgm.	0.907	181.00
6	” ”	0.831	165.20
15	” ”	0.880	176.00
19	” ”	0.705	141.00
23	” ”	0.511	102.20
3	400 kgm.	0.655	131.00
7	” ”	1.188	237.60
11	” ”	1.374	274.80
20	” ”	1.329	265.80
24	” ”	0.850	170.00
4	500 kgm.	0.950	190.00
8	” ”	0.711	142.20
12	” ”	0.853	164.60
16	” ”	0.875	160.00
25	” ”	1.089	209.00
5	600 kgm.	0.941	188.20
9	” ”	0.853	164.60
13	” ”	0.623	124.60
17	” ”	0.564	112.80
21	” ”	0.719	148.80

TABLE 8

Comparison of the different treatments in mean yields of lint per hectare

TREATMENTS COMPARED	DIFFERENCES IN MEAN YIELD	VALUE OF DIFFERENCE
	kgm.	
300—Control	81.08 ± 10.89	Very significant
400—Control	143.56 ± 18.62	Very significant
500—Control	93.63 ± 10.45	Very significant
600—Control	75.44 ± 12.24	Very significant
300—400 kgm.	62.48 ± 17.02	Significant
300—500 kgm.	12.56 ± 7.23	Insignificant
300—600 kgm.	5.64 ± 11.98	Insignificant
400—500 kgm.	39.92 ± 18.48	Insignificant
400—600 kgm.	68.12 ± 16.48	Significant
500—600 kgm.	18.20 ± 11.58	Insignificant

TABLE 9

Value of mean yield of lint per hectare

TREATMENT PER HECTARE	YIELD PER HECTARE	VALUE [a]
kgm.	*kgm.*	*pesos*
Control	71.96 ± 7.91	12.23
300	153.04 ± 7.49	26.02
400	215.52 ± 16.86	36.64
500	165.60 ± 6.83	28.15
600	147.40 ± 9.35	25.06

[a] Based on price per kilogram of lint quoted in *Philippine Commerce and Industry Journal,* April, 1933.

TABLE 10

Relative returns from the use of a 3-9-3 fertilizer mixture

AMOUNTS USED PER HECTARE	INCREASE IN LINT PER HECTARE	VALUE OF INCREASE	COST OF FERTILIZER	RETURN PER HECTARE	RETURN PER ₱1.00 WORTH OF FERTILIZER
kgm.	*kgm.*	*pesos*	*pesos*	*pesos*	*pesos*
Control ...	—	—	—	—	—
300 ...	81.08	13.78	12.58	+ 1.20	+ 0.10
400 ...	143.56	24.40	15.95	+ 8.45	+ 0.53
500 ...	93.64	15.92	20.63	− 4.71	− 0.23
600 ...	75.44	12.82	25.16	−12.34	− 0.48

NITROGEN PARTITION IN THREE NATIVE VARIETIES OF PIGEON PEAS, CAJANUS CAJAN (LINN.) MILLSP.[1]

ARMANDO M. LOCSIN

Cadios, or pigeon pea is found in relative abundance in Iloilo, Cavite and Batangas, and in lesser quantities in Negros. It is usually planted as a cover crop in sugar cane and rice fields. Among the Visayans, rich and poor alike, this particular legume is considered a table delicacy.

Although some amino acids are very important in nutrition (Osborne and Mendel, 1912a, 1912b, 1914a, 1914b, 1915a, 1915b, 1916a, 1916b; Brewster and Alsberg, 1919; Gilroy, 1930; Osborne and Leavenworth, 1916; Setch and Luck, 1925; Stewart, 1925; and Sure, 1920) a review of available literature showed that these substances have not been determined in the pigeon pea. This work was performed in the Department of Agricultural Chemistry from April, 1933 to February, 1934.

MATERIALS AND METHODS

Three native varieties of pigeon pea were used; namely, the black, brown, and the white. The Department of Agronomy, College of Agriculture, supplied the author with the white variety. The black variety was bought in the market of Iloilo and the brown variety in Batangas. The three varieties used in the analysis were all marketable but their degree of maturity when picked was not determined. Their proximate chemical analyses are shown in table 1.[2]

Sampling. One kilogram of each variety of ripe pigeon peas was ground. The ground material was then mixed thoroughly and passed through a 40 mesh sieve. The materials were then dried in the sun. The fat was removed by extracting the finely ground sample with ether. The removal of fat was found advantageous in that it obviated foaming during the hydrolysis of the sample and facilitated the measuring of an aliquot portion later in the analysis, by giving a clear liquid. The fat-free samples were placed in separate containers and sealed air-tight. The samples were then ready for analysis.

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[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 468; Experiment Station contribution, No. 1066. Prepared in the Department of Agricultural Chemistry under the direction of Dr. F. O. Santos.

[2] Analysis made in the Experiment Station Section, Department of Agricultural Chemistry, with the help of Mr. Lauro Ynalvez and Mrs. Mamerta Manahan-Ylagan.

Hydrolysis. Using 50 grams of each sample, the hydrolysis was carried out with 25 per cent hydrochloric acid in a 800 ml. Kjeldahl flask under a reflux condenser. At intervals of eight hours the hydrolysis was stopped; the flask and content were cooled, and a portion of 1 ml. withdrawn with a pipette. These portions were diluted to 10 ml., and the amino nitrogen was determined in the Van Slyke apparatus, the reaction being allowed to proceed for five minutes standing and then for one minute with shaking. The hydrolysis was continued until the amount of amino nitrogen in the hydrolyzate was constant. Forty-eight hours were required for the complete hydrolysis of the proteins in the sample.

Total nitrogen. After hydrolysis, the contents of the flask were filtered, and the residue was completely washed with hot water until free from chlorides. The residue was subjected to the Kjeldahl method. The residue for the white variety was found to contain 0.14 per cent nitrogen, the black, 0.15 per cent nitrogen and brown, 0.19 per cent nitrogen. The hydrolyzate was concentrated under diminished pressure in order to remove as much of the hydrochloric acid as possible. The syrupy residue was taken up with warm distilled water and transferred to a measuring flask of 1000 ml. capacity and then diluted to the mark. Aliquot portions were taken for the determination of the total nitrogen, on the basis of which the final results were calculated.

Amino acid determination. The analysis of the amino acid content of the hydrolyzate was carried out by the Van Slyke method, as described by Plimmer and Rosedale (1925), with slight modifications. All total nitrogen determinations were made by the modified Kjeldahl-Gunning-Arnold method using 2 grams of copper sulfate and 5 grams of potassium sulfate and boiling for three hours after the solution had turned clear or clear blue. The amino nitrogen determination in the di-amino fraction was made at room temperature by the reaction with nitrous acid for one hour and in the mono-amino fraction for half an hour.

Arginine nitrogen was determined according to the technique of Plimmer (1916).

Cystine nitrogen was determined according to the method of Plimmer and Lowndes (1927).

The value for histidine was obtained with the use of the formula: — Histidine N = 3/2 (D- ¾ Arg. N). Lysine was calculated with the use of this relation:— Lysine N= Total N of the di-amino fraction — (Arginine N + Cystine N + Histidine N).

RESULTS AND SUMMARY

The results of the analysis are shown in table 2. No cystine nitrogen was found by the method of Plimmer and Lowndes (1927). For purposes of comparison the nitrogen distributions in soybean and cowpea as found by Nollau (1915) are given in table 3.

1. The di-amino fraction of the three varieties contains relatively high amounts of arginine, lysine, the differences in the value of the three varieties being slight; and fair amounts of histidine.
2. The percentage nitrogen in the mono-amino fraction of the three varieties is about one-half of the total amino acids present.
3. A comparison of the amino acid content of pigeon pea with that of soybean and cowpea shows certain peculiarities, such as the apparent absence of cystine in pigeon pea and its presence in soybean and cowpea, the absence of histidine in cowpea and the presence of relatively large amounts of histine nitrogen in the three varieties of pigeon pea and fair amounts in soybean.
4. The question whether the peas, if planted under similar climatic and soil conditions and harvested at the same stage of maturity, would give similar results or not remains to be investigated.

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TABLE 1

Showing the proximate chemical analysis of three native varieties of pigeon peas

VARIETIES OF PIGEON PEA	MOISTURE	FATS	ASH	PROTEIN (N × 6.25)	CRUDE FIBER	N. F. E.	CALORIFIC VALUES
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*calories per 100 grams*
White	15.63	28.64	4.81	23.06	8.91	18.95	440
Black	10.57	29.67	4.86	23.38	8.26	23.26	465
Brown	10.20	8.15	4.22	20.75	9.19	47.49	355

TABLE 2

Showing nitrogen distribution in three varieties of pigeon pea[a]

FORMS OF NITROGEN	VARIETIES OF PIGEON PEA					
	White[b]		Black[b]		Brown[b]	
	per cent		*per cent*		*per cent*	
T. N. of the hydrolyzate	3.54		3.57		3.11	
Amide N		9.68		10.91		10.89
Humin N		1.31		1.27		1.46
T. N. of di-amino fraction	32.52		34.95		31.61	
Arginine N		17.09		17.03		14.59
Histidine N		3.27		6.25		6.51
Cystine N		—		—		—
Lysine N		12.16		11.67		10.51
Amino N	17.53		18.02		16.33	
T. N. of mono-amino fraction	53.03		51.30		56.19	
Amino N		52.82		51.15		55.21
Non-Amino N		0.21		0.15		0.98
T. N. recovered		96.54		98.43		100.15

[a] Results expressed as average of three samples.
[b] Results expresssd as percentage of total nitrogen in hydrolyzate.

TABLE 3

Showing the distribution of nitrogen in soybean and cowpea

FORMS OF NITROGEN	SOYBEAN	COWPEA
	per cent	*per cent*
Amide N	12.97	11.83
Humin N	3.69	9.57
Cystine N	1.52	6.74
Arginine N	15.52	15.98
Histidine N	2.60	0.00
Lysine N	7.02	3.56
Amino N of filtrate (mono-amino fraction)	48.76	46.70
Non-amino N of filtrate (mono-amino fraction)	7.12	0.58
Total	99.20	94.96

THE EFFECTS OF VARIOUS AMOUNTS OF SHRIMPS AS A SUPPLEMENT IN RATIONS FOR GROWING PIGS [1]

MOISES G. ANGEL

To grow pigs rapidly and with profit, attention should be given to the feeding of rations that satisfy the physiological needs of the pigs and are economical for the owner. Studies in the College of Agriculture on the use of shrimps as a supplement to rations for growing pigs have shown that they are superior in many respects to any one of the feeds with which they have been compared, copra meal for instance. Because of the high cost of shrimps, however, it is essential that hog raisers should know just what amount should be added as a supplement to a basal ration in order to obtain the most satisfactory results.

REVIEW OF PAST WORK

Bolivar (1928) found that weanling pigs in dry lot receiving for 55 days a cooked ration consisting of 20 parts corn, 60 parts rice bran, 15 parts copra meal and 5 parts shrimps made an average daily gain of 0.11 kgm. and required 4.72 kgm. of feed to produce one kgm. gain. The second lot which was fed the same ration mixture, except that it was not cooked, made an average daily gain of 0.16 kgm. and required 4.04 kgm. feed to make one kilogram gain.

The same author conducted a second set of experiments in which he fed 3 lots of weanling pigs on common grass pasture for 70 days with the same ration used in experiment I. The average daily gain of the 3 lots was 0.18 kgm. per head, and 3.49 kgm. of feed were required to produce one kilogram gain.

In his third set of experiments, covering a period of 70 days, 3 lots of weanling pigs on grass pasture were fed the same ration as in the first and second sets. He found that the 3 lots made an average daily gain of 0.14 kgm. per pig, and consumed 3.35 kgm. feed to produce one kilogram gain.

Garrido (1930) in his work on the preparation of rations as related to growth and development of pigs fed 6 lots of weanlings the same ration mixture used by Bolivar (1928), but the pigs in this experiment were on camote pasture for a period of 213 days. Garrido found that the lots made an average daily gain of 0.27 kgm., requiring 3.37 kgm. feed to make one kilogram gain.

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Mondoñedo and Bayan (1927) compared the feeding value of cassava with corn by feeding 2 lots of weanling pigs on sweet potato pasture for 70 days. Lot I was given a ration of 40 parts corn, 40 parts rice bran, 15 parts copra meal and 5 parts shrimps; lot II was given a ration of 20 parts corn, 20 parts cassava, 40 parts rice bran, 15 parts copra meal and 5 parts shrimps. The two lots made an average daily gain of 0.21 kgm. and consumed 2.77 kgm. feed for every kilogram gain.

When the same lots of pigs were placed in dry lots and were fed the same ration for the next 70 days, the lots made an average daily gain of 0.16 kgm. and required 6.65 kgm. feed for every kilogram gain.

Mondoñedo (1928) in his feeding trial on the value of ground corn and chopped cassava fed a lot of pigs 8 months old in dry lot a ration consisting of 20 parts corn, 70 parts rice bran, 8 parts copra meal and 2 parts shrimps. The animals made an average daily gain of 0.36 kgm., requiring 4.32 kgm. ration to make one kilogram gain.

Perez (1932) compared copra meal, shrimps and tankage as supplements to a basal ration for pigs. He fed the shrimps lot on common grass pasture a ration consisting of 20 parts corn, 60 parts rice bran, 15 parts copra meal, and 5 parts shrimps for a 70-day period. The lot made an average daily gain of 0.22 kgm., requiring 4.02 kgm. feed for every kilogram gain.

In the next 70-day feeding periods, the same lot of pigs made an average daily gain of 0.44 kgm. and consumed 2.89 kgm. feed to make one kilogram gain. In the third 70-day period, Perez used a ration consisting of 20 parts corn, 60 parts rice bran, 17 parts copra meal, and 3 parts shrimps. The lot made an average daily gain of 0.49 kgm. and consumed 4.04 kgm. feed for every kilogram gain.

Santiago (1926) in his study on copra meal and dried shrimps as supplements to a basal ration consisting of corn and rice bran for growing pigs fed 2 lots of weanling pigs for 70 days. He found that the pigs on the shrimps ration with a nutritive ratio of 1:5.4-1:5.5 made an average daily gain of 0.27 kgm. and consumed 4.71 kgm. ration for every kilogram gain. The copra meal lot on a ration with about the same nutritive ratio averaged .07 kgm. gain and consumed 10.03 kgm. to make one kilogram gain.

Soriano (1931) fed for 70 days five lots of weanling pigs on a ration of 20 parts corn, 60 parts rice bran, 17 parts copra meal and

3 parts dried shrimps and found that lot I, (full ration, on dry lot) made an average daily gain of 0.19 kgm.; lot II (limited ration with sweet potato soilage), 0.18 kgm.; lot III (limited ration with calopogonium soilage), 0.15 kgm.; lot IV (full ration with sweet potato pasture), 0.23 kgm.; and lot V (full ration with calopogonium pasture) 0.15 kgm. Lot I required 3.88 kgm. ration to make a kilogram gain; lot II, 2.7 kgm.; lot III, 3.13 kgm.; lot IV, 2.11 kgm.; and lot V, 3.20 kgm.

Tirol (1933) in comparing the feeding value of coarse and standard rice bran for growing pigs found that the standard rice bran lot was superior to the rest of the lots. The standard rice bran lot was fed a ration consisting of 20 parts corn, 60 parts standard rice bran, 15 parts copra meal, and 5 parts shrimps. The pigs were on pasture. During the first 70-day period, the lot made an average daily gain of 0.15 kgm. and consumed 3.44 kgm. ration per kilogram gain. For the second 70-day period, the same lot made an average daily gain of 0.28 kgm., requiring 3.97 kgm. ration to make a kilogram gain. And for the third 70-day period, the lot made an average gain of 0.33 kgm. daily and required 5.22 kgm. ration for every kilogram gain.

OBJECT, PLACE AND TIME OF THE PRESENT WORK

The object of the present work was: To determine the effects of various amounts of shrimps as a supplement in rations for growing pigs.

The work was conducted in the Department of Animal Husbandry, College of Agriculture, Los Baños, from October 24, 1931 to May 21, 1932. It was divided into three 70-day periods in order to determine the effects of the various amounts of shrimps upon the animals at different ages.

MATERIALS

Growing pigs

The animals used in this experiment were twenty-four Berkjala weanling pigs, twelve females and twelve castrated males. The animals were rather spare in flesh.

Feeds and rations used

The feeds used and their prices at the time this experiment was conducted were as follows:

Corn	4.91	centavos	per	kgm.
Rice bran	4.74	”	”	”
Copra meal	4.20	”	”	”
Shrimps	23.2	”	”	”

In previous experiments where 20 parts corn, 60 parts rice bran and 20 parts copra meal constituted the ration for growing pigs, satisfactory results were obtained. Other trials showed that this ration can be improved by the addition of dried shrimps. The present work attempted to determine the optimum amount of dried shrimps that should be added. The feed mixture used in the former experiments, that is: 20 parts corn, 60 parts rice bran and 20 parts copra meal was used as the basic feed for all the lots and various amounts of shrimps were added, thus forming the following modified rations.

Lot I received 95 parts of the basic feed + 5 parts shrimps.
Lot II received 90 parts of the basic feed + 10 parts shrimps.
Lot III received 85 parts of the basic feed + 15 parts shrimps.
Lot IV received 80 parts of the basic feed + 20 parts shrimps.

In addition to the rations listed above the following mineral mixture was given:

40 parts common salt
40 parts charcoal
18 parts lime
2 parts copperas

For every 100 kgm. of feed mixture, 1.5 kgm. of the mineral mixture were added. In addition, 10 grams of potassium iodide in water solution to a pig for a 70-day period were also given.

A one-fourth hectare lot was made available for all the four lots for the entire period of the test.

EXPERIMENT AND METHODS

The experiment

First 70-day period. A study of the effects of the rations given to the pigs from two and a half to five months old.

Second 70-day period. A study of the same rations given to the pigs from five months to seven and a half months old.

Third 70-day period. A continuation study of the same rations for pigs seven and a half months to nine months old.

Summary of the results of the three periods combined into a 210-day feeding period.

Feeding and management

The pigs were divided into four lots with six animals to a lot. The lots were made as even as possible according to condition, weight and sex.

The animals in each lot were given as much feed as they would consume. They were hand-fed twice daily between five and six o'clock in the morning and between four and five o'clock in the afternoon. After each feeding all the animals from the different lots were driven together into a mixed grass pasture.

After feeding in the morning and at noon, clean water in a clean trough was placed in the hog pen where the pigs could have access to it at will.

The initial and final weights of each pig were the average of the weights taken for three consecutive days at the beginning and at the close of the feeding test. Weekly weights were taken between three o'clock and four o'clock in the afternoon throughout the 210-day period. The animals were weighed individually.

Except for the difference in the rations received by the lots, the pigs were given the same treatment throughout the course of the experiment. During the whole feeding period, all the animals were allowed to run together between meals in the common one-fourth hectare grass pasture. The pigs could go into the hog pen at will from the pasture. Just before noon the animals were given camote soilage at the rate of one per cent of the total live weight of the pigs taken weekly.

Table 1 shows the average daily gain, the amount and cost of feed consumed per kilogram gain, or the feeding efficiency expressed in percentage of rations as affected by the amount of shrimps added.

OBSERVATIONS

On November 19, 1931, it was discovered that some of the animals of the herd were infested with ascaris. The pigs that showed signs of ascariasis; namely, pig 1392 in lot I; pigs 1461 and 1474 in lot II; and pig 1409 in lot III were treated with a vermifuge.

On February 14, 1932 pig 1409 in lot III, which had not been doing well ever since it was treated for ascaris in November, died and upon post-mortem examination it was found to be infested with kidney worms. On March, 1932, pig 1461 in lot II died and post-mortem examination showed that the animal had kidney worms.

RESULTS

1. During the first 70-day period, from the point of view of rapidity of gains made, lot II (10 per cent shrimps) gave the best results, with lot III (15 per cent shrimps) second, lot IV (20 per cent shrimps) third, and lot I (5 per cent shrimps) decidedly the poorest. In feed cost, lot II was the most economical with lot I, second, lot III, third, and lot IV, fourth.

2. In the second and third 70-day periods the 5 per cent shrimps lot gave the best results in every respect, with the 10, 15 and 20 per cent lots following in the order named.

3. Taking the three partial periods as a whole feeding trial of a 210 day period the lot fed 5 per cent, proved to be the best, followed by the 10, 15, and 20 per cent lots in the order named.

DISCUSSION OF RESULTS

The amount of feed required to produce one kilogram of gain, the cost of this feed and the rapidity of gain in weight were taken as measures of the comparative efficiency of the different rations.

First 70-day period. It may be noted in table 1 that lot II made the most rapid rate of gain followed by lots III, IV and I in the order named. Lot I made an average daily gain of 0.17 kgm.; lot II, 0.23 kgm.; lot III, 0.21 kgm.; and lot IV, 0.20 kgm. When these differences in results obtained are expressed in percentage, taking lot I as 100 per cent, lot II is 131.0 per cent, lot III, 125.0 per cent and lot IV, 120.0 per cent.

As to the amount of feed needed to make one kilogram gain in weight, lot I required 4.32 kgm. feed; lot II, which was the best, 3.30 kgm.; lot III, 3.45 kgm.; and lot IV, 3.61 kgm.

The results obtained showed that for pigs two and one-half to five months old, 10 per cent shrimps is about the optimum amount that should be used. Except for the first half of the period of feeding, 15 and 20 per cent appear to be so much in excess of what the pigs needed as to lower the rate of gain and increase the amount of feed required for a kilogram gain. The nutritive ratio of lot III ration is 1:3.4 and lot IV ration, 1:2.8, both of which are narrower than that required for pigs of similar weight and age according to the modified Wolff-Lehmann feeding standard, which is about 1:4.0 to 1:4.5. On the other hand, the nutritive ratio of the 5 per cent shrimp ration, 1:5.0, was altogether too wide and, hence, unbalanced.

As to the feed cost for a given unit of gain, however, lot I was second to lot II; lot III was third and lot IV, fourth. Lot I required ₱0.24 worth of feed for every kilogram gain; lot II, ₱0.21; lot III, ₱0.26; and lot IV, ₱0.30.

It may be of interest to note that the rate of gain and the amount of feed consumed by lot I compare favorably with the results obtained by Mondoñedo and Bayan (1926) and Tirol (1932) and others who had used the same ration in their studies.

Second 70-day period. In this period (see table 1), lot I made an average gain of 0.33 kgm. a day; lot II, 0.32 kgm.; lot III, 0.30 kgm.;

and lot IV, 0.30 kgm. Lot I consumed 3.55 kgm. feed to produce one kilogram gain; lot II, 3.63 kgm., lot III, 3.86 kgm. and lot IV, 3.93 kgm. The cost of feed per kilogram gain for lot I was ₱0.20; lot II, ₱0.20; lot III, ₱0.29; and lot IV, ₱0.33. In rapidity of gain and feed required for a kilogram gain, lot I gave the best results, with lots II, III and IV following in the order named.

It is interesting to note that lot I which made the lowest rate of gain during the first 70-day period, ranked first in every respect in the rapidity of gain, feed required per kilogram gain and the cost of feed per kilogram gain. Lot IV very markedly became the poorest in every respect. The results showed that pigs from five months old up to the time they are about seven and one-half months old needed less protein for their growth than they did in the first 70-day period; and 5 per cent shrimps in the ration appeared to be the optimum amount. Lot IV pigs which received a ration with 20 per cent shrimps, having a nutritive ratio of 1:2.86, gave the poorest result of the four lots, showing that the pigs not only had no need for such a large amount, but in some way or another the excess did them harm.

Third 70-day period. In this period, as in the previous one, lot I gave the best results in all respects with lots II, III, and IV following in the order named. Lot I made an average daily gain of 0.42 kgm.; lot II, 0.34 kgm.; lot III, 0.28 kgm.; and lot IV, 0.24 kgm.

Lot I required 4.03 kgm. feed for every kilogram gain; lot II, 4.78 kgm., lot III, 5.34 kgm.; and lot IV, 5.77 kgm. Expressed in percentage, assuming lot I to be 100 per cent, lot II was 84 per cent, lot III, 75 per cent and lot IV, 70 per cent.

With regard to the cost of feed necessary for each kilogram gain, lot I required ₱0.22 worth of feed; lot II, ₱0.33; lot III, ₱0.40; and lot IV, ₱0.48.

The results show that the difference in this period is more marked than in the second period, indicating the gradual decrease in the protein requirements of growing pigs with increase in age.

The 210-day test. The results were similar in tendencies to those obtained in the second and third 70-day periods. Thus, lot I made an average daily gain of 0.31 kgm.; lot II, 0.30 kgm.; lot III, 0.26 kgm.; and lot IV, 0.25 kgm.

As to the amount of feed needed for a kilogram gain; lot I required 3.97 kgm.; lot II, 3.90 kgm.; lot III, 4.22 kgm.; and lot IV, 4.44 kgm. Expressing the difference in percentage, assuming lot I to be 100 per cent, lot II was 102 per cent, lot III, 94 per cent, and lot IV, 89 per cent.

From the point of view of economy of gain, lot I was the most economical, requiring ₱0.22 worth of feed for every kilogram gain; lot II, ₱0.25; lot III, ₱0.31; and lot IV, ₱0.37.

Lot I on a 5 per cent shrimps ration was the slowest in making gains during the early part of the feeding trial, that is, when the pigs were very young, showing that their ration was deficient in comparison with the other rations. As the pigs grew older, however, they gradually rose to the first place showing that the ration they had been getting more fully supplied their needs. This showing is fully in consonance with the fundamental principle that the younger the pigs the narrower the nutritive ratio of the ration, with a certain limit, and as they grow older, until full grown, the wider the ration.

Lot IV on 20 per cent shrimps ration was the best during the first six weeks of the test, showing that for rapidly growing pigs the ration they were getting was about the best of the four rations used. From that time on, however, the rapidity of gain became slower and slower until it became the poorest of the four lots. This decline points out the impracticability when the pigs are older and, possibly, the harmful effect of continuing a ration that is suited for very young pigs. The death of one pig in lot II and one in lot III really did not alter the relative position of the four lots as to differences in results. The death of the animals, however, did raise the averages of the two lots concerned. The cause of death in each case according to post-mortem finding was kidney worm infestation.

SUMMARY OF CONCLUSIONS

1. From the point of view of rate of gain and the amount of feed consumed per kilogram gain, the ration with 10 per cent shrimps added gave the best results during the first 70-day period. Following in the order named were the rations with 15, 20 and 5 per cent shrimps added to each. In the cost of feed per kilogram gain, lot I was second to lot II and lot III was third and lot IV was fourth.

2. In the second and third 70-day periods the 5 per cent of shrimps gave the best results in every respect followed by lots II, III, and IV in the order named.

3. Taking the whole feeding trial as one experiment of 210 days duration, rations with 5 per cent shrimps proved to be the best as to rapidity of gain and cost of feed for every kilogram gain with lots II, III, and IV in the order named. As to the amount of feed per kilogram gain, lot II was slightly better than lot I, and lot III was third and IV, fourth.

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TABLE 1

Showing the average daily gain, and the amount and cost of feed consumed per kilogram gain by lots

	LOT I	LOT II	LOT III	LOT IV
First 70-day period				
Number of pigs in experiment	6	6	6	6
Average initial weight of pigs (kgm.)	10.92	10.92	10.97	10.93
Average daily gain (kgm.)	0.17	0.23	0.21	0.20
Average daily feed consumption (kgm.)	0.72	0.76	0.74	0.74
Feed consumed per kgm. gain (kgm.)	4.32	3.30	3.45	3.61
Feed cost per kgm. gain	₱0.24	₱0.21	₱0.26	₱0.30
Feeding efficiency of supplements based on feed required per kgm. gain	100%	131%	125%	120%
Second 70-day period				
Number of pigs in experiment	6	6	6	6
Average initial weight of pigs (kgm.)	22.58	27.02	25.97	25.17
Average daily gain (kgm.)	0.33	0.32	0.30	0.30
Average daily feed consumption (kgm.)	1.18	1.15	1.15	1.16
Feed consumed per kgm. gain (kgm.)	3.55	3.63	3.86	3.93
Feed cost per kgm. gain	₱0.20	₱0.20	₱0.29	₱0.33
Feeding efficiency of supplements based on feed required per kgm. gain	100%	98%	92%	90%
Third 70-day period				
Number of pigs in experiment	6	6	6	6
Average initial weight of pigs (kgm.)	45.93	57.40	51.72	45.73
Average daily gain (kgm.)	0.42	0.34	0.28	0.24
Average daily feed consumption (kgm.)	1.67	1.63	1.51	1.40
Feed consumed per kgm. gain (kgm.)	4.03	4.78	5.34	5.77
Feed cost per kgm. gain	₱0.22	₱0.33	₱0.40	₱0.48
Feeding efficiency of supplements based on feed required per kgm. gain	100%	84%	75%	70%
Whole 210-day period				
Average daily gain (kgm.)	0.31	0.30	0.26	0.25
Average daily feed consumption (kgm.)	1.19	1.18	1.13	1.10
Feed consumed per kgm. gain (kgm.)	3.97	3.90	4.22	4.44
Feed cost per kgm. gain	₱0.22	₱0.25	₱0.31	₱0.37
Feeding efficiency of supplements based on feed required per kgm. gain	100%	102%	94%	89%

THE EFFECTS OF THE APPLICATION OF DIFFERENT AMOUNTS OF LIME UPON THE YIELDS OF SUGAR CANE UNDER LOS BAÑOS CONDITIONS [1]

VICENTE B. ARANCILLO

Of all commercial fertilizers used in sugar cane cultivation lime is the cheapest. It has both physical and chemical effects upon soil. The physical effect is to reduce the size of the clods, thus making the soil porous and easier to cultivate; the chemical effect is to make available plant food that otherwise would not be used.

The present work was undertaken with the hope of adding to the knowledge of effects of lime upon sugar cane in this country.

The work was conducted with the following objects in view: (*a*) to determine the soil reaction of the land to be used; (*b*) to find the effects of different amounts of lime upon the soil reaction and upon the yields of cane and sugar per hectare; and (*c*) to determine the gain or loss due to the application of lime.

This work was carried out in the Experiment Station of the College of Agriculture, from December, 1932 to March, 1934, covering a period of about 14 months.

The field had an area of 8,064 square meters. The soil is heavy clay loam. Cane variety POJ 2878 was used.

The lime used was bought in Manila. When analysed in the Department of Agricultural Chemistry, it gave 45.86 per cent calcium (CaO) as available lime.

The pH value of the soil was determined by the quinhydrone electrode method. Two soil samples were taken from each plot and the pH value was determined with the help of Dr. D. I. Aquino, of the Department Soils.

The land was prepared in the usual way. The field was plowed four times and harrowed after each plowing. Native implements were used. Just before the application of lime and the planting of the seed pieces, furrows one meter apart were made, the plow was run twice along each furrow.

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[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 470; Experiment Station contribution No. 1068. Prepared in the Department of Agronomy under the direction of Dr. Valeriano C. Calma.

The field was divided into four lots, each 84 by 24 meters, giving an area of 2,016 square meters. Each lot was subdivided into four plots, 84 by 6 meters, giving an area of 504 square meters. The plots were laid alternately so as to lessen, so far as possible, errors resulting from variability in soil fertility.

All the seed pieces used were about 25 to 30 cm. long and each had two to five buds, The points were soaked in running water for about 24 hours before planting.

Lime was applied in different amounts in each of three lots and the fourth lot served as control. The lime was applied as follows: First lot, 126 kgm. (57.78 kgm. of CaO) per plot or two and one half tons per hectare; second lot, 252 kgm. (115.57 kgm. of CaO) per plot or five tons per hectare; and third lot, 504 kgm. (231.13 kgm. of CaO) per plot or ten tons per hectare. The lime was broadcast in the furrow just before planting. The distance between hills was 75 cm. and between the rows, 100 cm. The hills were arranged in quincunx, that is, the hills in the second furrow formed the vertexes of equilateral triangles with those in the first furrow and so on. The double-point method, that is two points to a hill, was used.

The whole culture was given the same treatment. The canes were cultivated three times with a native plow. The first cultivation was a hilling-up process on March 30, 1933. On June 10, 1933 the cultures were off-barred. The third and last cultivation, on August 10, 1933, was hilling-up or closing-in.

Periodic observations were made from the time of planting up to harvesting. The percentage of germination was determined by going over the rows in each plot and counting the number of living hills in each row. At maturity, lodging, the degree of tillering, flowering, attack of pests and diseases were noted, and juice analyses and the actual yield of cane and sugar were determined.

On February 17, 1934, the composite cane samples from the different plots were harvested, weighed, milled and analysed separately in the College Sugar Mill through the help of Dr. Getulio Guanzon, of the Department of Agricultural Chemistry. A composite sample of the crushed juice from each plot was analysed and the degree Brix and polarization were determined. From these and other data the apparent purity, base per cent sugar, piculs sugar per hectare and piculs sugar per ton cane of each plot were determined with the use of Warren's table and the *Chemical Control for Cane Sugar Factories* published (1921) by the Association of Hawaiian Sugar Technologists.

Only the millable stalks were harvested and milled. A cane stalk that measured one meter or more from the ground to the last visible node was considered a millable stalk, and a stalk less than one meter from the ground to the last visible node was considered non-millable.

In computing the gain or loss resulting from the application of lime, only the cost of lime, cost of its transportation from Manila to College, and cost of application were considered. The yield of each treated plot was compared with that of the control. The price of a picul of sugar was assumed to be ₱6.20. The value of the difference in yields minus the total cost of lime, cost of its transportation and cost of its application gave the gain or loss resulting from the lime.

RESULTS AND DISCUSSIONS

Comparative vigor of plants of the different treatments. The plants of the three different treatments were vigorous. It was noted, however, that those in plots fertilized with 2.5 tons lime per hectare were the most vigorous. The two other treatments produced plants of practically the same vegetative vigor as the control.

Comparative maturity of plants under the different treatments. The plants under the different treatments flowered at practically the same time; most of the canes were in bloom on October 30, 1933. This observation indicates that the maturity of POJ 2878 is not influenced at all by the application of lime.

Pests and diseases. Pink mealy bug, *Trionymus sacchari* Cockerell and leaf hopper, *Perkinsiella vastatrix* Breddin were found on some plants in all the different treatments. The effects of these pests were so slight as to be considered negligible. No major sugar cane disease was observed in any of the cultures. But leaf spot disease caused by *Cercospora kopkei* Kr. was noted in plants of each treatment.

Soil reaction. Table 1 shows the pH value of the soil before and after the application of lime. It may be seen that before the application of lime the soil of the field was acidic in reaction, with an average range of 6.58 to 6.59 pH. About thirteen months after the application of lime the soil became basic; the pH value ranged from 7.26 to 7.73. For every increase in the amount of lime applied there was a corresponding increase in the pH value of the soil. Also, the pH value of the control plots was increased from 6.58 to 7.26.

This increase in the pH value of the control plots may be explained as follows: The control plots were laid in between the plots fertilized with lime. The plots were narrow, being only six meters wide with six rows in a plot. Undoubtedly, the rain water washed of some of the lime of the treated plots on to the control plots.

Germination of seed pieces resulting from the different treatments. It may be noted in table 2 that the percentage of germination resulting from the different treatments ranged from 63.40 to 74.96. The seed pieces in the plots that were fertilized with 2.5 tons of lime per hectare had the highest percentage of germination, with an average of 74.96 per cent. The seed pieces in the control plots had the lowest germination, with an average of 63.40 per cent. This result indicates that lime improves germination, probably owing to its toxic effect upon the anay, *Macrotermis gilvus* Hagen and pineapple disease caused by *Ceratostomella paradoxa* Dade, (*Thielaviopsis paradoxa* [De Seyn.] von Hoehnel), both commonly found attacking seed pieces of sugar cane in this locality. Calma (1933) and Valera (1934) found that the pineapple disease caused by *Ceratostomella paradoxa* Dade, (*Thielaviopsis paradoxa* [De Seyn.] von Hoehnel) was one of the factors responsible for low germination of seed pieces of sugar cane. Part of the beneficial effects of lime on germination may be due to its quality of absorbing moisture from the surrounding area, thus giving enough for germination of the dormant eye buds. The percentage of germination decreased, however, as the amount of lime added was increased. This effect may be accounted for, in part, by the toxic effects of an excess of lime upon the young dormant buds of the seed pieces.

The degree of tillering resulting from the different treatments. It may be seen in table 3 that the plants from the treated plots produced more millable and non-millable stalks than those from the control. The differences, however, are insignificant. This result indicates that lime has no effect upon the production of stalks of sugar cane.

Yield of cane and sugar resulting from the different treatments. Table 4 shows the average yield of cane and sugar per hectare and piculs sugar per ton cane resulting from the different treatments. It may be seen in this table that the average yield of cane per hectare ranged from 30.667 ± 1.919 to 46.849 ± 2.029 tons. The highest average yield, 46.849 ± 2.029 tons per hectare was obtained from plots fertilized with 2.5 tons per hectare. The lowest average yield, 30.667 ± 1.919 tons cane per hectare, was obtained from the control plots. The plots fertilized with 2.5 tons of lime to the hectare produced 16.182 ± 2.793 tons cane per hectare more than the control plots; this difference is significant. When the yields of cane per hectare of the other treated plots were compared with that of the control plots the differences were insignificant. It is interesting to note in table 4 that the plots fertilized with 2.5 tons lime to the hectare exceeded in yield by a significant difference of 13.873 ± 2.566 tons the plots fertilized with 10 tons to the hectare.

Table 4 also shows that under the different treatments the yields of sugar per hectare were affected practically the same as the yields of cane. The plots fertilized with 2.5 tons lime to the hectare gave the highest yield of sugar per hectare, 102.079 ± 4.965 piculs; the control plots gave the lowest yield, 69.450 ± 2.025 piculs. The difference of 32.529 ± 5.366 piculs sugar per hectare is insignificant. When the yields of sugar of the other treated plots were compared with that of the control, the differences were insignificant. Likewise, the difference between the yield of sugar of the plots fertilized with 2.5 tons and 5 tons lime to the hectare, was insignificant. The plots fertilized with 2.5 tons lime to the hectare, however, gave a yield of 29.769 ± 6.272 more piculs sugar per hectare than the plots fertilized with 10 tons lime to the hectare. This higher yield is significant.

On the whole, these results indicate that lime had a beneficial effect upon the yield of the cane and sugar of the cane crop in this experiment. The application of 2.5 tons lime to the hectare, which was the minimum amount used, approached the optimum; for every increase over 2.5 tons in the amount of lime added, there was a corresponding decrease in the yield of cane and sugar per hectare. Lee (1929) reported that the application of two metric tons of lime materials to the hectare was almost certain to give a profitable increase in yield of cane and sugar.

Had no lime washed to the soil of the control plots, the treated plots would have given more significant differences in yield of cane and sugar per hectare when compared with the control. About six to seven months after planting the writer believes that some of the lime washed into the control plots on rainy days.

Table 4 shows that the average yield of sugar per ton cane resulting from the different treatments ranged from 2.030 to 2.279 piculs. It may be seen in this table that the control plots gave the highest yield of sugar per ton cane. When the yields of sugar per ton cane of the different treatments were compared the differences were insignificant. Lee (1929) reported that whereas the two tons of *cagaycay* (lime) increased the piculs sugar per ton cane, the larger amounts lowered the piculs sugar per ton cane.

Gain or loss due to lime applications. It may be noted in table 5 that the plots fertilized with 2.5 tons lime to the hectare gave a computed gain of ₱151.08 per hectare. A loss of ₱10.91 per hectare was obtained from the plots fertilized with 5 tons to the hectare and a loss of ₱184.08 from those fertilized with 10 tons to the hectare. These results indicate that the application of lime at a rate higher than 2.5 tons per hectare may not be profitable under local conditions, for the value of any increase in yield resulting from an application of lime of more than 2.5 tons to the hectare was not equal to the cost of application.

SUMMARY AND CONCLUSIONS

The results of this investigation may be summarized as follows:

1. Studies were made to determine the soil reaction before the application of lime and the effects of the different amounts of lime upon the soil reaction and the yield of cane and sugar per hectare. The gain or loss resulting from application of lime was also determined.

2. Before the application of lime the soil of the field was acidic in reaction with a pH value ranging from 6.58 to 6.59. About thirteen months after the application of lime, the soil became basic in reaction; the pH value ranged from 7.26 to 7.73. For every increase above 2.5 tons in the amount of lime added there was an increase in the pH value of the soil. After the application of lime, the pH value of the soil of the control plots was increased from 6.58 to 7.26. This increase may have been due to the washing off, during heavy rains, of lime in solution from the treated plots to the control plots.

3. The plots fertilized with 2.5 tons lime to the hectare produced the most vigorous plants. The other treated plots produced plants of practically the same vegetative vigor as the control. The application of lime had no influence on the maturity of the plants. The effects of pests and minor diseases were negligible.

4. The seed pieces from the plots that were fertilized with 2.5 tons of lime to the hectare had the highest percentage of germination, with an average of 74.96. The control plots with 63.40 per cent germination had the lowest. This difference indicates that lime improves germination, probably owing to its toxic effects upon the anay, *Macrotermis gilvus* Hagen and pineapple disease caused by *Ceratostomella paradoxa* Dade, (*Thielaviopsis paradoxa* [De Seyn.] von Hoehnel), both commonly found attacking seed pieces of sugar cane in this locality. The beneficial effects of lime on germination

may be accounted for, in part, by the absorbing quality of the lime by which it took up the moisture from the surrounding area, thus giving enough for germination of the dormant eye bud. The percentage of germination decreased as the amount of lime added was increased. This result may have been due to the toxic effects of an excess of lime upon the young dormant buds of the seed pieces.

5. The plants of the plots fertilized with lime produced more millable and non-millable stalks than those of the control, but the differences were insignificant.

6. The average yield of cane per hectare ranged from 30.667 ± 1.919 to 46.849 ± 2.029 tons. The plots fertilized with 2.5 tons lime per hectare gave the highest yield of canes and the control, the lowest. The plots fertilized with 2.5 tons of lime to the hectare produced 16.182 ± 2.793 tons more than the control plots, and 13.873 ± 2.566 tons cane per hectare more than the plots fertilized with 10 tons lime to the hectare. These differences are significant. When the yields of cane per hectare of the other treated plots are compared with that of the control plots the differences are found to be insignificant. The plots fertilized with 2.5 tons lime to the hectare gave the highest yield in sugar, 102 ± 4.965 piculs to the hectare, and the control plots with 69.450 ± 2.025 piculs, the lowest yield; the difference of 32.529 ± 5.363 piculs sugar per hectare is significant. The plots fertilized with 2.5 tons lime to the hectare gave a yield of 29.768 ± 6.272 piculs sugar per hectare more than the plots fertilized with 10 tons lime to the hectare; this is a significant difference. When the yields of sugar of the other treated plots are compared with that of the control, the differences are found to be insignificant.

7. The yield of sugar per ton cane ranged from 2.030 to 2.279 piculs. When the yields of sugar per ton cane from the different treatments were compared, the differences were found to be insignificant.

8. The plots fertilized with 2.5 tons lime to the hectare gave the highest computed gain, ₱151.64 per hectare. The plots fertilized with 5 and 10 tons lime to the hectare gave a computed loss of ₱10.91 and ₱184.08 per hectare, respectively.

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TABLE 1

Showing the soil reaction resulting from the application of different amounts of lime[a]

LIME APPLIED PER HECTARE	NUMBER OF REPLICATIONS	pH AVERAGE OF EIGHT DETERMINATIONS; TWO SAMPLES PER PLOT	
		Before liming	After liming [b]
tons			
2.5	4	6.59	7.48
5	4	6.58	7.61
10	4	6.59	7.73
Control	4	6.58	7.26

[a] pH was determined by quinhydrone electrode.

[b] pH after liming was determined when canes were about thirteen months old.

TABLE 2

Showing the percentage of germination resulting from the application of different amounts of lime

LIME APPLIED PER HA.	PLANTED HILLS	HILLS WITH PLANTS	GERMINATION [a]
tons	*number*	*number*	*per cent*
2.5	2,664	1,997	74.96
5	2,664	1,935	72.27
10	2,664	1,767	66.33
Control	2,664	1,689	63.40

[a] The percentage of germination was found by dividing the number of hills with plants by the number of planted hills and multiplying the quotient by 100.

TABLE 3

Showing the comparative degree of tillering under different application of lime

LIME APPLIED PER HA. COMPARED	STOOLS OBSERVED	AV. NUMBER OF MILLABLE STALKS PER STOOL	AV. NUMBER OF NON-MILLABLE STALKS PER STOOL
2.5 tons	372	3.72 ± 0.03	1.57 ± 0.02
Control	372	3.66 ± 0.03	1.36 ± 0.10
Difference		0.06 ± 0.04	0.21 ± 0.10
		Insignificant	Insignificant
5 tons	372	3.73 ± 0.03	1.52 ± 0.01
Control	372	3.66 ± 0.03	1.36 ± 0.10
Difference		0.07 ± 0.04	0.16 ± 0.10
		Insignificant	Insignificant
10 tons	372	3.77 ± 0.03	1.51 ± 0.07
Control	372	3.66 ± 0.03	1.36 ± 0.10
Difference		0.11 ± 0.04	0.15 ± 0.12
		Insignificant	Insignificant
2.5 tons	372	3.72 ± 0.03	1.57 ± 0.02
5 tons	372	3.73 ± 0.03	1.52 ± 0.01
Difference		0.01 ± 0.04	0.05 ± 0.02
		Insignificant	Insignificant
2.5 tons	372	3.72 ± 0.03	1.57 ± 0.02
10 tons	372	3.77 ± 0.03	1.51 ± 0.07
Difference		0.05 ± 0.04	0.06 ± 0.07
		Insignificant	Insignificant
5 tons	372	3.73 ± 0.03	1.52 ± 0.01
10 tons	372	3.77 ± 0.03	1.51 ± 0.07
Difference		0.04 ± 0.04	0.01 ± 0.07
		Insignificant	Insignificant

TABLE 4

Showing the average yield of cane and sugar per hectare and piculs sugar per ton cane resulting from the different treatments

LIME APPLIED PER HA.	AV. YIELD OF CANE PER HA.	AV. YIELD OF SUGAR PER HA.	AV. YIELD OF SUGAR PER TON CANE
	tons	*piculs*	*piculs*
2.5 tons	46.849 ± 2.029	102.079 ± 4.965	2.239 ± 0.028
Control	30.667 ± 1.919	69.450 ± 2.025	2.279 ± 0.117
Difference	16.182 ± 2.793	32.629 ± 5.363	0.040 ± 0.120
	Significant	Significant	Insignificant
5 tons	41.424 ± 3.299	84.005 ± 4.790	2.030 ± 0.603
Control	30.667 ± 1.919	69.450 ± 2.025	2.279 ± 0.117
Difference	10.757 ± 3.817	14.555 ± 5.207	0.267 ± 0.221
	Insignificant	Insignificant	Insignificant
10 tons	32.976 ± 1.571	72.311 ± 3.832	2.133 ± 0.301
Control	30.667 ± 1.919	69.450 ± 2.025	2.279 ± 0.117
Difference	2.309 ± 2.480	2.871 ± 4.335	0.146 ± 0.323
	Insignificant	Insignificant	Insignificant
2.5 tons	46.849 ± 2.029	102.079 ± 4.965	2.239 ± 0.028
5 tons	41.424 ± 3.299	84.005 ± 4.790	2.030 ± 0.603
Difference	5.425 ± 3.860	18.074 ± 6.899	0.210 ± 0.603
	Insignificant	Insignificant	Insignificant
2.5 tons	46.849 ± 2.029	102.079 ± 4.965	2.239 ± 0.028
10 tons	32.976 ± 1.571	72.311 ± 3.832	2.133 ± 0.301
Difference	13.873 ± 2.566	29.768 ± 6.272	0.106 ± 0.302
	Significant	Significant	Insignificant
5 tons	41.424 ± 3.299	84.005 ± 4.790	2.030 ± 0.603
10 tons	32.976 ± 1.571	72.311 ± 3.832	2.133 ± 0.301
Difference	8.448 ± 3.653	11.694 ± 6.135	0.103 ± 0.651
	Insignificant	Insignificant	Insignificant

TABLE 5

Showing the gain or loss under the different applications of lime

LIME APPLIED PER HA.	AV. YIELD PER HA.	TOTAL COST OF LIME APPLICATION PER HA.[a]	INCREASE IN YIELD	VALUE OF INCREASE PER HA.[b]	GAIN OR LOSS DUE TO LIME [c]
tons	*piculs*	*pesos*	*piculs*	*pesos*	*pesos*
2.5	102.079	50.65	32.629	202.30	+151.65
5	84.005	101.15	14.555	90.24	— 10.91
10	72.311	201.81	2.861	17.73	—184.08
Control	69.450	—	—	—	—

[a] Cost of lime per ton was ₱15.00.
Cost of labor per hour was assumed to be ₱0.10.
Cost of transportation of lime from Manila to College was ₱5.00 per ton.
[b] Current price of sugar per picul assumed to be ₱6.20.
[c] "+" indicates gain and "—", loss.

THE VALUE OF CASSAVA REFUSE MEAL IN THE RATION FOR GROWING CHICKS[1]

TEODORICO T. TABAYOYONG

WITH ONE CHART

Cassava as a crop is becoming popular in many parts of the Philippines, as is manifested by the gradually increasing number of farmers who have started to grow cassava and manufacture cassava starch. In the manufacture of the starch, cassava refuse meal is produced as a by-product in amounts ranging, according to Alzona (1933), from 43.2 to 62.0 per cent with an average of 52.6 per cent. The present work was undertaken to determine whether or not cassava refuse meal may be used in combination with other feeds for chicken feeding. The results may prove to be of benefit to both the cassava and the poultry industries.

Review of literature on the subject

Hansson (1913) fed, for 12 weeks, four lots of pigs with average weights of from 47 to 48 kilograms. In this test, barley, peas, and cassava bran fed with whey, boiled Swedish turnips and peanut cake were compared. Hansson found that the barley lot made a gain of 0.548 kilogram a head daily; the lot fed barley and pea meal, 0.574 kilogram; and the lot fed barley and cassava bran, 0.584 kilogram. He concluded that, in feeding value, 1.1 kilograms of cassava bran proved equal to 1 kilogram of barley or 0.95 kilogram pea meal. He also found that cassava bran had a beneficial influence on the quality of the pork and on the slaughter weight of the swine. This cassava bran, as Hansson describes it, is a refuse material obtained in the manufacture of cassava starch.

Henke (1923) compared cassava meal, cassava molasses meal and dried pineapple waste as feeds for growing and fattening hogs. He used three lots of Berkshire pigs each of which received rolled barley, cracked corn, wheat middlings, and tankage in separate self-feeders and were given daily equal amounts of green alfalfa. In addition to these rations, lot 1 received cassava meal, lot 2, cassava molasses meal, and lot 3, dried pineapple waste. During the 12-week test, the average daily gain per pig of lot 1 was 0.504 kilogram, lot 2, 0.468 kilogram, and lot 3, 0.445 kilogram. Lot 1, the cassava meal lot, required 3.47 kilograms of concentrates to produce one kilogram of gain; lot 2, the cassava molasses meal lot, 3.79 kilograms; and lot 3, the dried pineapple waste lot, 3.53 kilograms of concentrates to produce one kilogram of gain. This cassava meal was probably obtained by grinding the whole roots.

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[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 471; Experiment Station contribution No. 1069. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

Penuliar (1933) compared cassava refuse meal with rice bran as feeds for growing and fattening pigs. Basing the comparison on the amount of feed required for a unit of gain, Penuliar observed that, on an average, the feeding efficiency of cassava refuse meal was only 62 per cent when rice bran was considered 100 per cent. He further found that taking both the rapidity of gain and feed requirement per unit of gain as a measure of efficiency and giving equal weight, the average efficiency of the cassava refuse meal was only 57 per cent when compared with rice bran.

No studies so far have been reported as to the feeding value of cassava refuse meal for poultry.

The present work

The object of the present work was to determine the comparative feeding value for growing chicks of cassava refuse meal and rice bran.

The work was begun in September, 1932 and closed in August, 1933.

MATERIALS AND METHODS

Plan of the experiment. The chicks used in the experiment were artificially hatched from Los Baños Cantonese eggs laid by the College flock. Three hatches of chicks were used. The first hatch was taken off on August 30, 1932. This consisted of 240 chicks and was divided into three lots of 80 chicks each. The second hatch of 240 chicks was taken off on December 11, 1932 and was divided into three lots of 80 chicks each. The third hatch of 141 chicks was taken off on May 24, 1933, and was divided into three lots of 47 chicks each.

The chicks were brooded in fireless brooders. They were given the same ration consisting of equal parts of palay and corn, and were hand fed. The mash mixture used for each lot consisted of the following ingredients, all parts by weight.

FEEDS	LOT 1 (CONTROL)	LOT 2 (CASSAVA REFUSE MEAL-RICE BRAN)	LOT 3 (CASSAVA REFUSE MEAL)
Rice bran	6	3	—
Cassava refuse meal	—	3	6
Corn meal	2	2	2
Shrimp meal	2	2	2

The rice bran used in this experiment was the first class "Cono" rice bran. This rice bran contains 10.64 per cent moisture; 5.82 per cent fats; 14.17 per cent ash; 10.35 per cent proteins; 12.72 per cent crude fiber, and 46.29 per cent carbohydrates.[2]

The cassava refuse meal used was the by-product obtained in the manufacture of cassava starch. When dried it is in the form of cake. Before feeding, the cassava refuse cake was ground in the form of meal very similar in appearance to rice bran. The meal looks fibrous, but on analysis, it was found to contain only 1.22 per cent ash and 4.66 per cent crude fiber. It also contains 10.56 per cent moisture, 0.62 per cent fats, 1.03 per cent proteins, and 81.91 per cent carbohydrates.

During the first week the mash was moistened with egg, using one egg a day for every 30 chicks. During the second week, the egg was gradually reduced by allowing only one egg every other day for every 30 chicks. The chicks for the first two weeks received mash, then till weaning, they were fed one part mash and one part grain. The grain ration for all the lots from the second week to the eighth week was ground. After the eighth week the grain ration was composed of cracked corn and whole palay.

The mash feeds for all the lots were placed in an open trough to which the chicks had free access. Clean fresh water was available to the chicks the whole day. They were given chopped green grass every day.

Cost of feeds. The cost of feeds used are as follows:

Palay	₱0.051	a	kilogram
Corn	₱0.050	"	"
Rice Bran	₱0.035	"	"
Shrimps	₱0.121	"	"
Cassava refuse meal	₱0.020	"	"

Basing the calculations on the current market prices of the feeds, one kilogram of the mash for lot 1 cost ₱0.055, lot 2, ₱0.051, and lot

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[2] The feeds were analyzed in the Department of Agricultural Chemistry, College of Agriculture.

3, ₱0.046. One kilogram of the grain ration for the three lots cost ₱0.051.

Records. From the first day of the experiment till the end of the twelfth week when the experiments were closed, the chicks were weighed weekly. The individual weights were recorded. The feed consumption of each lot was also recorded. Close observations were made on the mortality of the chicks in each lot, and on their vigor and health.

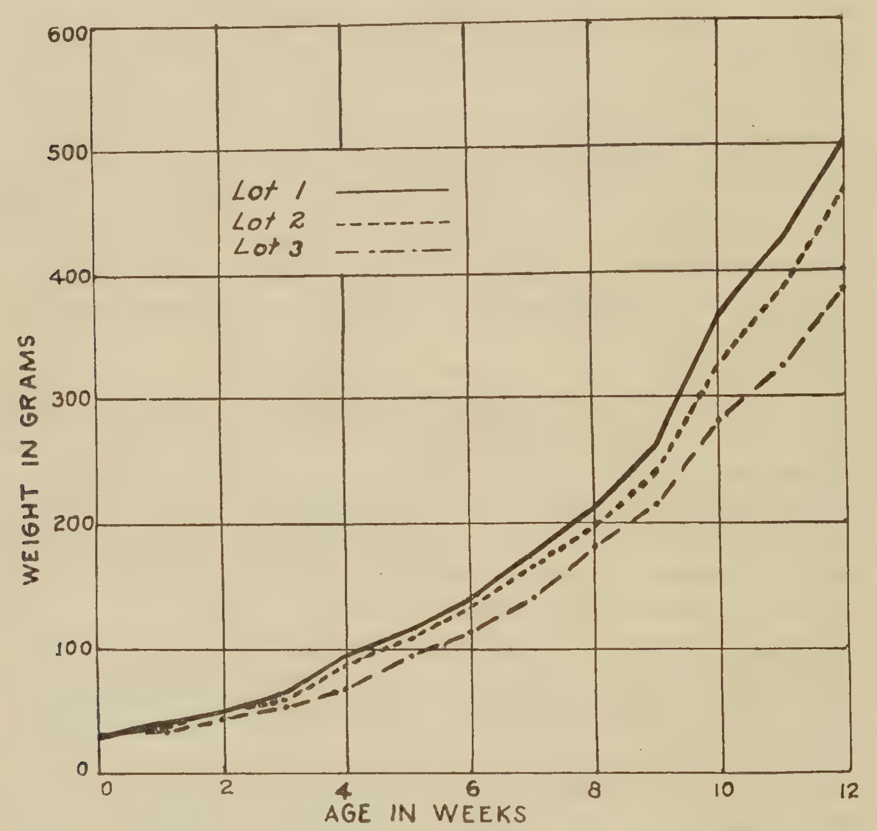

Chart 1.—Showing the rate of growth of the chicks in the different lots.

RESULTS AND DISCUSSIONS

Growth of chicks. The weights of the chicks at different ages were used as the criteria in determining their comparative growth in this study. These weights are given in table 1 and graphically presented in chart 1. In this table and in the chart it may be seen that the chicks in lot 1, (control lot) were consistently heavier in weight than those in lot 3 (cassava refuse meal lot). This difference in weight of the chicks in lot 1 and lot 3 persisted up to the end of the brooding period, twelve weeks, when the experiment ended. In weight, lot 2 (cassava refuse meal-rice bran lot) was intermediate between the weights of the two lots, but with a tendency to approach the weight of the chicks in lot 1. A very marked difference in the rate of growth of chicks in lots 1 and 3 was observed from the beginning to the end of the experiment. It was also observed that the chicks in lot 2, cassava refuse meal-rice bran fed lot, were a little heavier than those in lot 3, cassava refuse meal fed lot. The difference in the rate of growth of the chicks in lots 1 and 2 was not great, except in the tenth, eleventh, and twelfth weeks when the chicks in lot 2 lagged behind considerably.

The mean weights of the chicks in all the lots at the age of twelve weeks were as follows: Lot 1 had a mean of 501.7 ± 7.580 grams; lot 2, 463.4 ± 43.270 grams; lot 3, 388.0 ± 31.300 grams. The difference of the means of lots 1 and 3 was 113.7 ± 32.181; lot 1 was significantly the better. A comparison of lots 2 and 3 gave the difference of the two means of only 75.4 ± 53.403 which is insignificant. Likewise, when the means of lots 1 and 2 were compared, the difference was only 38.3 ± 43.911 which is also insignificant. These weights are a little higher than those reported by Amon (1930) and Dañgilan (1924).

Considering the ration given to lot 1, the rice bran fed lot, as 100 per cent in its effect on the rate of growth of the chicks, that given to lot 2, the cassava refuse meal-rice bran lot, is only 92.3 per cent, and the ration given to lot 3, the cassava refuse meal lot, is only 77.3 per cent.

Amount and cost of feeds consumed. Table 2 shows the relative amount and cost of feeds consumed at different periods. In this table, it was observed that lot 1, the check lot, consumed the most feeds; lot 2, the cassava refuse meal-rice bran lot and lot 3, cassava refuse meal lot, consumed about the same amount of feeds.

It will be noted in table 2 that the cost of the feed consumed differed in the three lots studied. This difference was due to the rice bran which cost more per kilogram than the cassava refuse meal. The cost of feed required to produce a weanling chick in the rice bran fed lot was ₱0.135; in the cassava refuse meal-rice bran fed lot, ₱0.116; in the cassava refuse meal lot, ₱0.108.

Value of gain less the cost of feed consumed. Table 3 shows the costs of weanling chicks produced and the cost of feeds consumed per 100 weanlings. From this table, it may be observed that lot 1 gained in weight more than lot 3; and lot 2 gained a little more than lot 3. By reference to tables 2 and 3, it may be seen that lot 1, the rice bran fed lot, required 5.3 kilograms of feeds to produce one kilogram of gain; and lot 3, the cassava refuse meal lot, required 6.3 kilograms. Subtracting the average cost of feed consumed from the value of the gain in weight, it is found that the value of lot 1 gains is ₱15.12; lot 2, ₱14.68; and in lot 3, only ₱10.94. The cost of a kilogram gain in lot 1, the rice bran fed lot, was ₱0.53; in lot 2, ₱0.56; and in lot 3, the cassava refuse meal lot, ₱0.50.

Mortality of chicks. Table 4 shows a comparison of mortality in the three lots computed on the basis of four weeks. The first four weeks showed a high mortality of chicks in all the lots. Lot 3, the cassava refuse meal lot had the highest percentage of mortality. During the period of the first set of observations, heavy rains and typhoons occurred which were in part responsible for the high mortality of the chicks in this set, as many chicks became chilled and died. During the last eight weeks, the mortality of the chicks was fairly low. The deaths of the chicks in lot 1 during the last eight weeks was due to roup, and 22 of the chicks during the first four weeks in the first set were killed by a cat. These 22, however, were not included in the mortality figures. The cause of deaths of chicks in lot 2 was roup and impacted crop; and 17 of the chicks in this lot during the first four weeks in the third set were killed by a dog, but these were not included in the mortality figures. The causes of deaths of chicks in lot 3 were roup and impacted crop.

Minor observations. The chicks in lot 1 (rice bran fed lot) were observed to be more uniform in size than the chicks in lot 3, (cassava refuse meal fed lot) in which most of the chicks were somewhat stunted in growth and in other ways rather unthrifty. In lot 2 (cassava refuse meal-rice bran fed lot) the chicks were more uniform in size than those in lot 3. It was also observed that the chicks fed with rice bran (lot 1) were more uniform in size than those fed with cassava refuse meal-rice bran (lot 2). When the coefficient of variability of the weights of the chicks at the age of 12 weeks was determined, lot 1 was observed to have a coefficient of variability of only 26.46 per cent; lot 2, 32.26 per cent; and lot 3, 46.67 per cent. The color of the shanks, beaks and skin of the chicks was yellow in all the lots. The feathers of the chicks in lots 1 and 2 developed earlier than those in lot 3.

SUMMARY AND CONCLUSIONS

1. The rice bran fed chicks grew faster than those fed cassava refuse meal. The chicks fed with a combination of cassava refuse meal and rice bran were intermediate in size between those fed rice bran and those fed cassava refuse meal, with a tendency to approach those of rice bran.

2. The chicks in the control lot consumed the largest amount of feed; the amounts consumed by lots 2 and 3 were about equal.

3. The average cost of feed consumed per 100 chicks to weaning age, twelve weeks, in the rice bran fed lot was ₱13.51; in cassava refuse meal-rice bran fed lot, ₱11.61; in cassava refuse meal fed lot, ₱10.83.

4. The amount of feed per kilogram gain in weight in lot 1 was 5.3 kilograms; in lot 2, 5.2; and lot 3, 6.3.

5. The cost of feed required to produce one kilogram gain in weight in lot 1 was ₱0.026; lot 2, ₱0.025; and lot 3, ₱0.027.

6. The costs of the gains in weight at sixty centavos a kilogram were; in lot 1, the rice bran fed lot, ₱28.63; in lot 2, the cassava refuse meal-rice bran fed lot, ₱26.29; and in lot 3, the cassava refuse meal fed lot, ₱21.77.

7. The cassava refuse meal fed chicks had the highest percentage of mortality, 59.4; and those fed rice bran, 41.5; and those fed cassava refuse meal-rice bran, 42.5, the last two being about the same.

8. The chicks in the rice bran fed lot, control lot, were more uniform in size than those fed with cassava refuse meal. But those fed cassava refuse meal-rice bran were more uniform than those fed with cassava refuse meal, though not as uniform as those fed with rice bran.

9. Considering the efficiency of the ration given to lot 1, rice bran, as 100 per cent in its effect on the rate of growth of chicks, the ration containing a combination of cassava refuse meal and rice bran was 92.3 per cent, and the cassava refuse meal was only 77.3 per cent.

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TABLE 1

Showing the average weekly weights of chicks in all the lots raised to 12 weeks old

AGE	LOT 1 (RICE BRAN LOT)		LOT 2 (CASSAVA REFUSE MEAL-RICE BRAN LOT)		LOT 3 (CASSAVA REFUSE MEAL LOT)	
	Number of birds	Average weights	Number of birds	Average weights	Number of birds	Average weights
		grams		*grams*		*grams*
At hatch	207	24.6 ± 0.539	207	25.3 ± 0.686	207	25.1 ± 0.609
1 week	176	36.5 ± 2.120	191	34.8 ± 0.993	173	33.7 ± 0.843
2 weeks	148	46.9 ± 3.246	175	48.5 ± 4.212	147	42.1 ± 0.885
3 "	137	61.6 ± 5.668	163	58.5 ± 3.763	129	51.5 ± 0.998
4 "	128	92.8 ± 4.550	133	84.1 ± 2.646	117	67.7 ± 0.575
5 "	121	112.9 ± 9.578	123	105.0 ± 6.752	101	94.0 ± 2.376
6 "	118	138.8 ± 16.006	117	134.7 ± 10.853	95	112.8 ± 2.040
7 "	114	173.1 ± 14.832	115	167.7 ± 9.878	92	139.3 ± 0.403
8 "	110	211.7 ± 24.639	111	199.4 ± 12.026	90	180.4 ± 9.162
9 "	107	259.7 ± 19.513	107	243.8 ± 8.013	89	216.6 ± 10.947
10 "	101	363.7 ± 19.459	102	327.0 ± 20.114	86	281.7 ± 12.507
11 "	99	427.4 ± 15.021	102	389.2 ± 33.064	85	324.0 ± 23.507
12 "	99	501.7 ± 7.480	102	463.4 ± 43.270	84	388.0 ± 31.300

TABLE 2

Showing the amount and cost of feed consumed by 100 chicks raised to 12 weeks old

FEED	LOT 1 (RICE BRAN)	LOT 2 (CASSAVA REFUSE MEAL-RICE BRAN)	LOT 3 (CASSAVA REFUSE MEAL)
Grain, kgm.	118.7	105.0	104.0
Mash, kgm.	135.9	122.7	120.3
Total, kgm.	254.6	227.7	224.3
Cost	₱13.51	₱11.61	₱10.83
Feed consumed per chick, kgm.	2.55	2.28	2.24
Cost of feed consumed per chick	₱0.135	₱0.116	₱0.108

TABLE 3

Showing data on cost and gain

ITEMS	LOT 1 (RICE BRAN FED LOT)	LOT 2 (CASSAVA REFUSE MEAL-RICE BRAN)	LOT 3 (CASSAVA REFUSE MEAL)
Initial weight per 100 chicks (1 day old)	2.46 kgm.	2.53 kgm.	2.51 kgm.
Weight at 12 weeks old (per 100 chicks)	50.17 ”	46.34 ”	38.80 ”
Increase in weight	47.71 ”	43.81 ”	36.29 ”
Value of the gain at ₱0.60 per kgm.	₱28.63	₱26.29	₱21.77
Cost of feed consumed per 100 chicks	₱13.51	₱11.61	₱10.83
Gain less cost of feed consumed	₱15.12	₱14.68	₱10.94

TABLE 4

Showing the average mortality of chicks in the three sets

PERIODS	LOT 1 (RICE BRAN)		LOT 2 (CASSAVA REFUSE MEAL-RICE BRAN)		LOT 3 (CASSAVA REFUSE MEAL)	
	Number of birds	Mortality	Number of birds	Mortality	Number of birds	Mortality
		per cent		*per cent*		*per cent*
At hatch	207		207		207	
1-4 weeks[a]	128	27.5	133	27.5	117	43.4
4-8 ”	110	14.0	111	16.5	90	23.0
8-12 ”	99	10.0	102	8.1	84	6.6
Total	—	41.5	—	42.5	—	59.4

[a] Cat killed 22 chicks in lot 1; dog killed 17 chicks in lot 2.

ABSTRACT[1]

A preliminary study of inter-cropping sugar cane with legumes and different degrees of cultivation. LORENZO J. VALDEZ. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 472; Experiment Station contribution No. 1070.*)—The author conducted the study with the following objects: (*a*) To find if certain legumes could be successfully inter-cropped with a ratoon crop of sugar cane; (*b*) to determine the comparative effects of inter-cropping with calopogonium, *Calapogonium mucunoides* Desv. I, peanut, *Arachis hypogaea* Rac., and soybean, *Glycine max* (Linn.) Merr. upon the growth of weeds and cane; (*c*) to determine the comparative effects of different degrees of cultivation upon the growth of weeds and canes; (*d*) to determine the comparative effects of inter-cropping with calopogonium, peanut and soybean upon the yields of cane and sugar of ratoon crop; (*e*) to determine the comparative effects of different degrees of cultivation upon the yields of cane and sugar of ratoon crop; and (*f*) to determine the comparative effects of inter-cropping with the different legumes, and different degrees of cultivation upon the yields of cane and sugar of ratoon crop.

A first ratoon of Luzon White with a little mixture of Pampanga Red was used. The field used was composed of three lots, the areas of which were 7,749.00 sq. m., 3,650.64 sq. m. and 2,410.80 sq. m. The field was divided into 28 plots.

The legumes used were calapogonium, peanut and soybean. They were planted in the designated plots with four replications each. The seeds were planted at the rate of 33.88 liters per hectare in the furrows made after the first hilling-up.

The four degrees of cultivation were two-cultivation, four-cultivation which served as the control, six-cultivation, and eight-cultivation, each with four replications.

The calopogonium was not harvested as it matured late. The peanuts were not harvested for fear of injuring the cane plants. The soybeans were harvested 189 days after planting. The harvest, yield of beans, and weight of straw of each plot were determined.

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[1] Abstract prepared as part of required theme work in English 3a, College of Agriculture.

The canes from each plot were harvested, weighed, milled and analyzed in the usual manner. From the degree Brix and the per cent polarization, the apparent purity, base per cent sugar, tons sugar per hectare, piculs sugar per hectare, and piculs sugar per ton cane of each plot were determined using Warren's table and that of the *Chemical Control for Cane Sugar Factories* prepared by the A. H. S. T.

The following results and conclusions were obtained by the author:

1. Calopogonium was the most effective in controlling the weeds, but when used as an inter-crop, it had a decidedly harmful effect, for it lowered both the tonnage per hectare and the quality ratio.

2. Soybeans and peanuts each had about the same abundance of weeds as the control. Both of them were recommended as good legumes for inter-cropping with sugar cane for they increased the yield of the cane, and saved two processes of cultivation, off-barring and hilling-up. The peanuts gave an average yield of 5.865 ± 4.5054 tons cane, and an average of 10.534 ± 8.1196 piculs sugar per hectare higher than the control; the soybeans gave an average yield of 1.764 ± 4.1052 tons cane and 2.321 ± 7.6704 piculs sugar per hectare higher than the control.

3. The yields of soybeans were high in the plots where cane yields were low and vice versa. In plots that gave a good growth, the amount of straw produced compared favorably with the amount that Layosa obtained in his field tests of soybean experiment which he conducted in 1918. The yield of soybean seeds was low compared with the yield that Grageda obtained in his experiment in 1917, and with the yield that Layosa obtained. The plot that gave the highest yield, produced 1,020.33 kilograms of straw per hectare as compared with 1,066 kilograms obtained by Layosa, and the same plot gave a yield of 204.7 kilograms of beans as compared with 383 kilograms obtained by Grageda.

4. Inter-cropping sugar cane ratoons when the canes were hip-high or about three months old with legumes was found to be rather late.

5. As the degree of cultivation was intensified, the abundance of weeds was lessened. Plots that were cultivated six times produced the most vigorous cane plants; the plots that were cultivated eight times produced cane plants that showed yellowing of the leaves one week after the eighth cultivation.

6. The average yields in both cane and sugar per hectare increased as the plants were given more cultivation, but the quality ratio was not influenced by the degree of cultivation.

7. With the exception of the peanut plot, which on an average gave a higher quality ratio than the four-cultivation, the plots given different degrees of cultivation gave higher quality ratio than the plots inter-cropped with different legumes.

8. Comparing the plots inter-cropped with different legumes, the plot inter-cropped with calopogonium gave the lowest yields with an average of 2.389 ± 4.1073 tons cane and an average of 9.663 ± 6.529 piculs sugar per hectare lower than the control. The plots inter-cropped with peanuts gave the highest average yields of both cane and sugar per hectare, with an average of 5.865 ± 4.5054 tons cane, and an average of 10.534 ± 8.1119 piculs sugar per hectare higher than the control. The plots inter-cropped with soybeans gave higher yields of both cane and sugar per hectare than the control with averages of 1.764 ± 4.1052 tons cane and 2.321 ± 7.6704 piculs sugar per hectare over the control.

9. Two-cultivation gave the lowest yields of both cane and sugar per hectare, for it gave 2.05 ± 4.0346 tons cane and 3.458 ± 7.3565 piculs sugar per hectare lower than the control. Six-cultivation gave average yields of 17.892 ± 2.8781 tons cane and 31.775 ± 5.5073 piculs sugar per hectare higher than the control. Eight-cultivation gave the highest average yields of both cane and sugar per hectare, for it gave average yields of 36.34 ± 5.2105 tons cane and 20.154 ± 2.9199 piculs sugar higher than the control.

10. Peanuts, eight-cultivation, six-cultivation and soybeans gave average yields of both cane and sugar per hectare higher than the control; two-cultivation and calopogonium gave average yields of both cane and sugar per hectare lower than the control, in the order named.

As the results obtained for the different treatments gave insignificant differences, the author suggested further studies on the subject, using larger plots and adequate replications.

Abstract by Felicidad Y. Chan.

CURRENT NOTES

Though it is only in recent years that the importance of sugar as an energy generator of the body has been demonstrated, its consumption dates back to the days of early history. Honey was the first sweet substance known. The earliest use of confectionery was to disguise the taste of unpleasant drugs. Greek and Roman apothecaries smeared with honey the rim of a cup containing a bitter draught. Later it became a favorite practice to sweeten unpalatable medicines with sugar. It was only about two hundred years ago that the confectionery industry began to develop independently of its medicinal association. The true development, however, of the manufacture of confectionery started in the 19th century in England. After the great exhibition of English confectionery dealers in 1851, the trade spread to Germany, France, and the United States. Today the industry has attained vast proportions. Sales of confectionery and chocolate products in the United States during 1934, based on 321 manufacturers reporting to the Department of Commerce, were valued at $202,892,000.

Commander Byrd took with him two and one-half tons of candy on his trip to the South Pole..... As a source of energy sweets are unexcelled. Experiments have shown that fatigue or exhaustion can be prevented or lessened by the proper use of candy.

The Philippine Journal of Commerce, August, 1935.

One way of keeping the dietary nutritionally well balanced without going into calculations of calories or other food values is to let the purchase of the family's food be guided by two simple rules as follows:

(1) Spend as much for milk, cheese, and cream, if used, as for flesh, fish, and fowl; and

(2) Spend as much for vegetables and fruits as for all meats and fish.

Alabama School Journal, May, 1935.

Many branches of the organization, Agricultural Bureau, are working to a programme so designed that it provides members with seasonable and reliable technical advice and develops the habit of meeting regularly to take counsel together, thus building up an appreciation of the community spirit that is essential to the successful carrying out of voluntary cooperative ventures.

The Agricultural Gazette of New South Wales, July, 1935.

Interest has been created by the announcement that the Bureau of Sugar Experiment Stations had recently imported a number of specimens of the Giant American Toad (*Bufo marinus*) for ultimate release in the cane areas of Queensland....

The toad is a native of the tropical portions of America from Mexico to Argentine, but it has been introduced to several portions of the West Indies, to Hawaii and to Puerto Rico, where it has proved of economic significance in the control of certain insect pests. In the latter country it is credited with having reduced the white grub from the position of a major pest to one of comparative rarity. The present introduction to Queensland is made in the hope that it may prove an important factor in the control of the white grubs which inflict such costly damage in the cane fields. It is to be understood that the toad deals with the insect in the beetle stage.

The Australian Sugar Journal, July, 1935.

Wastage of citrus fruits in transit this year has been greater than in the previous seasons. The fungus responsible is the "green mould", which is all too common on fallen fruit in the Cyprus groves. It is known that this fungus can only attack fruit, the skin of which is broken by careless handling or by rubbing. Owing to the prevailing wet weather the skin of the oranges is exceptionally tender and very little pressure is needed to burst the fine skin of the oil cells. Once these are ruptured the fruit is readily attacked by the fungus. Special care must be taken this season to see that the fruit is not bruised or scratched during the picking and storing before wilting has been effected. All fruit should be clipped a second time to ensure that no portion of the stalk projects in contact. The worker's finger nails must be kept short and the wearing of gloves might be considered as a practical proposition.

The Cyprus Agricultural Journal, March, 1935.

The improvement of the produce of the soil and the consequent improvement in the conditions of rural life in India is the objective of every agricultural department in India. In the various departments of agriculture, workers in all branches of agricultural science—chemists, plant pathologists, entomologists, bacteriologists, botanists and agriculturists—have each contributed to the mass of knowledge which we possess today, and we are only just realizing that, if we are to exploit to the fullest economic advantage the results of scientific investigations in agriculture, we must add to the work of these specialists the labours of officers concerned with the investigations of marketing—the organization of production and exchange.

Agriculture and Live-stock in India, March, 1935.

COLLEGE AND ALUMNI NOTES

On August 3 the Rizal Center Fraternity initiated Dean Bienvenido Gonzales as an honorary member of the Fraternity. Those initiated as members of the Fraternity were Dr. Aniceto Ascalon, Professors Placido Dacanay and Alejandro de Mesa and Messrs. Andres P. Aglibut, Damaso Agudelo, Andres de la Cruz, Benjamin Eleazar, Marcial Enriquez, Isidro Macaspac and Miguel Manresa Jr. The traditional 'arroz caldo' was served after the initiation. The Supreme Noble of the Mother Chapter, Dr. Wenceslao Pascual accompanied by Nobles Dr. Hilario Lara, Dr. Mariano Ocampo and Mr. Jose Generoso, represented the fraters of the Mother Chapter at the initiation.

The one-hundred-and-fifth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Plant Physiology Building, College of Agriculture on Thursday, August 29, 1935, at 7:30 p. m.

The following papers were read and discussed.

1. "Sclerotium diseases of cotton"
   By Mr. M. S. Celino
2. "Comparative cost of operation of a Fordson tractor using kerosene and alcohol as motor fuels"
   By Prof. A. B. Catambay and N. L. Cuevas.
3. "A preliminary study of the comparative effects of fertilizing with ammonium sulfate and green manure upon the yields of sugar cane"
   By Dr. V. C. Calma and A. V. Andam.

Mr. Getulio B. Viado '35 is a recent addition to the Entomology Staff. His position is assistant. Mr. Viado is not without experience in his chosen work. After receiving his degree of B.Agr. in 1932 he was assistant entomologist with the Philippine Sugar Association for about a year and a half. While completing his work for degree of B. S. A. he worked on half day schedule as assistant in Entomology-Pathology section (including quarantine station) in Los Baños Economic Garden, Bureau of Plant Industry. During his whole college life he was a self-supporting student, being employed in departments of Agronomy, Chemistry and Entomology. His thesis on "Anatomical studies on white grubs affecting Philippine field crops" presented for graduation with degree of B.Agr. was awarded the "Lee Prize", as being the best thesis presented in the College in that year.

Mr. Viado is a member of The Society for the Advancement of Research and Rizal Center Fraternity, University of the Philippines. Also of The Latvian Exchange Club, The Danish International Correspondence and Exchange Club, both foreign organizations.

Mr. Osmundo Mondeñedo '35 now teaching in Tayabas Provincial High School in Lucena was a welcome caller recently. He is teaching Poultry and Swine Husbandry and reports liking the work.

Early in September, six Siamese students, Odd Janlaka, Ian Khampananda, Bhakdi Lusanandana, Prasert Nanakara, Aroon Songmani, Cawee Yansukontra entered the College. These young men, writes Thongdee Resananda '24 now Director, Department of Agriculture and Fisheries in Siam, were selected by competitive examination held under Government supervision. Out of thirty high school graduates who took the examination, nine who ranked highest were sent abroad as student pensionados. One to England, two to the United States, and six to this college. Director Resananda writing of his hopes from these and the other Siamese students in the College says: "They will come back and help me in my endeavor to do something along the line of Agriculture."

There are now thirty-five foreign students in this College, twenty-one of them from Siam.

In the evening of September 11 the College Cadets presented a most entertaining program in the Auditorium.

The cadet Band deserves commendation for its rendering of the overture, "L'Abeille Dor E. Pontet".

Other musical numbers were:

The Chinese folk song by Misses Helen Au Yeung, Lee Pao Shan, Cheung Sin Fong and Chan Shuk Yee.

Piano Solo by Cadet Lt. Romeo Espino and songs by Cadets Virgilio Celis and Mamerto Manahan, Cadet Lt. P. Mendoza,—"Old Faithful" by Sergeant Celis had a special appeal.

Borenzo Zialcita told very naturally the entertaining scientific (?) tale of "The Chimpanzee and the Chimpanzoo".

Fancy drill by eight cadets gave a pleasing military touch.

The short one-act play "The Traitor" by Percival Wilde presented by the Mimics under the direction of Professor Cole was a fine piece of work. The play itself is a tense bit of war life, restrained in language and action, admirably suited for Cadet Corps actors. The scene was in a C. O.'s tent in the Boer War. Members of cast were:

Colonel Sir Robert Anstruther, K.C.M.G.	Flaviano Olivares
Major MacLaurin, V.C.	Gabriel Flores
Captain Grantham	Vicente Lolingco
Captain Bates	Dionisio Abella
Captain Parker	Antonio Ocampo
Captain Willoughby	Romeo Espino
Lieutenant Edwards	Martin Rosell
Another Lieutenant	Melanio Rana
Orderly	Demetrio Miranda

IN MEMORIAM

TRINIDAD B. VILLAS, B.S.S.T. '32 *(cum laude)*

October 15, 1932–December 15, 1932, Special Analyst in Laboratory, Calamba Sugar Estate. Resigned, because of illness. November 20, 1933–May 6, 1935, Field Assistant, Experiment Station, Calamba Sugar Estate. Resigned, because of illness.

Canlubang, Laguna, September 18, 1935

CHARLES FULLER BAKER: A TRIBUTE

This "perfect tribute" is from Vice Governor Hayden's address on Loyalty Day 1935 in Baker Memorial Hall.

THE College of Agriculture of the University of the Philippines has a rich background of tradition. Consequently it has a distinctive personality. The fine, vigorous college spirit of the institution arises, in part, from the same source. Because I appreciate this spirit and am proud to have even a small part in an occasion that contributes to it I am happy to be here today. I am also honored to participate in a ceremony that recalls one of the men who inspired the tradition of Loyalty Day, the late Dean Baker. How well I recall him: snowy white hair, untamed like his own spirit; a keen, ascetic face with the brow of a scholar and the jaw of a fighter; a restless energy that in turn energized all of those about him, a commanding intellect and a great heart. Dean Baker himself has become a tradition upon this campus and his influence upon the life of this great institution will not soon cease. It is particularly fitting that Dean Baker's memory should be associated with the tradition of Loyalty Day because loyalty was one of his outstanding characteristics: loyalty to friends, loyalty to the institutions in which he believed, above all the loyalty of the scientist to truth!

MORPHOLOGICAL CONTRIBUTION ON THE GENUS ANONA LINNAEUS [1]

JOSE B. JULIANO
Of the Department of Plant Physiology

WITH THREE PLATES

The genus *Anona* is represented in the Philippines by five tropical American species; namely, *A. muricata* Linn. (guyabano, soursop), *A. reticulata* Linn. (anonas, bullock's heart, custard apple), *A. squamosa* Linn. (ates, atis, sugar apple, sweetsop), *A. cherimolia* Mill. (cherimoya), and *A. glabra* Linn. (mamon, pond apple). The last two species are recent introductions into the Islands; the first three were introduced by the Spaniards at an early date (Wester, 1912a, 1912b; Merrill, 1923-1926; and Zingg, 1934). Besides these five species, atemoya, a hybrid between *A. cherimolia* and *A. squamosa* (Wester, 1914a, 1914b), and many other hybrids (Wester, 1915) have been added to our collections. The present paper gives an account of the development of the flower, megasporange and gametophytes based on material collected from *A. muricata* and *A. squamosa*, both of which grow in the vicinity of the College and yield fair edible fruits.

Schnarf (1931) has recently summarized the morphological characters of the family Anonaceae as follows: The microspore mother cells are arranged in a single longitudinal row in each of the microsporanges of the anthers (*Anona*, *Xylopia* and *Monodora*), and between the mother cells is a sterile tissue. In *Cananga odorata* no septae are formed. Division of the microspore mother cell is simultaneous in *Anona cherimolia.* Successive divisions of the microspore mother cells reported in *Cananga odorata* and *Asimia triloba,* which require verification, is in direct contrast to that found in *A. cherimolia.* The megasporange is bitegumentary. In *A. cherimolia* and *Asimia triloba* a single primary archesporial cell is differentiated, which forms a parietal tissue; this was found to be true also of *Anona montana, Orophea hexandra, Unona dasymoschata* and *Cananga odorata.* The embryo sac at maturity is filled with an abundance of starch grains (*Cananga odorata*); the antipodals are three, small, and ephemeral. The endosperm is of the cellular type.

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[1] Experiment Station contribution, No. 1071. Received for publication March 4, 1935.

Licopoli (1888) studied the anatomy and physiology of the mature fruit of *A. reticulata* Linn. and *Asimia triloba* Dun. Voigt (1888) found that the rumination of the endosperm in Anonaceae (*Uvaria lowii, Melodorum latifolium, M. bandanum, Alphonsea ceramensis, Anona reticulata* and *A. squamosa*) is due mainly to the growth of the outer integument of the young seed.

Nicolasi-Roncanti (1904) published a description of the megasporange of *A. cherimolia.* He found a row of four megaspores, and a considerable parietal tissue. The innermost megaspore develops a narrow, much elongated embryo sac, the antipodals of which appear to be ephemeral. The first divisions of the endosperm cell result in the formation of a series of walls across the narrow sac which is thus divided into a linear series of five to six large chambers. Subsequent divisions fill these linear series of chambers with endosperm tissue. The rumination of the seed is attributed by this author to the invasion of the perisperm by infoldings and chiefly from the inner integument.

MATERIAL

The material used for this study was collected from April 7 to May 2, 1933, and from November, 1933 to February, 1934, from plants growing on the College of Agriculture Campus.[2] Flower buds at different stages of growth were gathered and these were killed and fixed either in the field or in the laboratory with the use of formalin-acetic-alcohol (70 per cent) and chromo-acetic stock solution prepared according to the formulae given by Chamberlain (1932). The material was treated as usual and embedded in paraffin. Sections, six to ten microns thick, were cut, and most of these were stained in Haidenhain's ironalum haematoxylin with Aniline orange gold dissolved in clove as a counterstain.

INVESTIGATION

The flower

Description. The flower of *A. squamosa* Linn. is rather small, solitary or fascicled (pl. 1, fig. 2) at the axils of the leaves, and is usually pendulous and pubescent. It is 3-angled, greenish-white or yellowish. It possesses three small, greenish calyx lobes which fuse early. Its petals are three, very much larger than the sepals, and alternate with the latter. The individual petal is long, fleshy, and is held at a nearly 30° angle at anthesis. The stamens are numerous, their anther cells being narrow, dorsal, and contiguous, with the tops of their connectives ovoid. All the stamens occupy the outer region of the enlarged receptacle or torus of the flower, and are held by short, rather robust filaments. The pistils are also numerous, their ovaries subconnate, each possessing an oblong style at the top of which is the stigma; megasporanges solitary, anatropous, although two megasporanges are not uncommon.

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[2] Collection of some of the material used in this study was made under the direct supervision of the writer by Messrs. Manuel L. Dinglasan and Porfirio R. Manacop, students in Plant Physiology 105.

The flower of *A. muricata* Linn. is often solitary, much larger than that of *A. squamosa,* yellowish or greenish yellow. The deep green calyx lobes are three, more or less obtuse and connate. Alternating with the three sepals are the three outer, rather stiff, fleshy, greenish-yellow outer petals which are broadly ovate, cordate. acuminate and very thickly coriaceous. Enclosed by these three outer petals are three inner petals which alternate with the outer ones and are opposite the sepals. The inner petals are also large, although a little smaller than the outer ones, elliptic to obovate, rounded, coriaceous, and yellowish. The stamens and pistils are numerous, and are arranged in the same manner as given in the description of *A. squamosa.*

It is interesting to note that most of the species of *Anona* readily respond to interspecific pollination as brought out by the results obtained by Wester (1910, 1914, 1915) in Florida and in the Philippines.

Anthesis. Results of observation by the writer on the time of anthesis of *A. muricata* flower show that its external petals begin to open between four and five in the afternoon; these are half open between six and seven the same day, although the internal petals are still closed. In an hour or so the external petals completely open and falling may take place as early as ten o'clock in the evening. The stamens at this time have already dehisced their microspores. The inner petals open very slightly, and usually persist much longer than the outer petals, although shedding of both inner and outer petals may take place simultaneously. In other words, anthesis and dehiscence are not synchronous in this species, and self-pollination is perhaps not the rule, although natural cross-pollination may take place in the early morning because at anthesis the flower usually emits a fragrance which attracts insect visitors. Besides, mature embryo sacs were observed by the writer in ovaries of flowers at the time the stamens had already dehisced their microspores—a point which shows that proterandry is the normal feature of this species.

Wester (1910) reports that the stamens of *A. cherimolia* and *A. squamosa* are attached to a large torus and are indefinite; they cohere by connective glands beyond the anthers surrounding the syncarpium in which an indefinite number of carpels are united. As the flowers reach maturity, a viscid fluid is secreted that covers the syncarpium, and which appears to be most abundant about twenty-four hours after dehiscence. Until the shedding of the microspores the petals assume an almost perpendicular position, and leave a small opening, facing downward, for the entrance of pollen-bearing insects. As the time of dehiscence approaches, the petals spread out and up so rapidly that movement is readily perceived. This phenomenon is accompanied by the exhalation from the flower of the *A. cherimolia* of a fragrance something like that of a well-ripened banana and from the *A. squamosa* of ethyl acetate. In *A. squamosa* the fragrance continues to be emitted for a few hours until the microspores are dehisced, after which it disappears and the petals wither. The stigma is readily approached by large as well as small insects and were the stamens and stigmas synchronous, self-pollination by the insects or the wind might be effected.

In fact, in Florida, Wester (1910) was able to find several species of insects visiting the flowers of some of the species of *Anona* he observed there. *Colastrus truncatus* was found in considerable numbers in flowers of *A. squamosa* and *Triphleps* (probably *insidiosus*) in cherimoya flowers. A beetle (*Phaxonothi* group) was found in flowers of *A. squamosa;* and in addition to these insects, small thrips also frequent the flowers of these anonas. The author believes that the thrips probably assist in the pollination to some extent. No attempt was made to observe local insect visitors of the two species of *Anona* reported in this paper.

Dehiscence. The importance of the knowledge of anthesis and related biological behavior of the flower, like dehiscence, can not be overestimated at this juncture. In *Anona muricata,* the writer observed that dehiscence of the anthers usually takes place before anthesis, but he did not definitely establish the exact time for such ejection of the microspores. However, Wester (1910) while working on the hybridization of four species of *Anona* in Florida, observed that their flowers are entomophilous and proterogynous. *A. cherimolia* and *A. reticulata* shed their microspores in the afternoon from about half past three to six o'clock; in *A. squamosa,* dehiscence takes place from daybreak to about nine o'clock in the forenoon, at which time practically all the microspores are shed. Some flowers, however, were found by Wester to shed their microspores in the afternoon. But no tree sheds its microspores in both afternoon and forenoon. In *A. glabra,* practically all the flowers shed their microspores in the early morning before sunrise, seldom in the afternoon.

That proterogyny is the rule in the species, as Wester (1910) claims, was definitely proved by him, when he performed a series of artificial self- and interspecific-pollinations done long before and at dehiscence of the microspores. In all cases where pollination was done at the time of dehiscence of the microspores, no fruit setting was observed, whereas, if pollination was done twenty-four hours or more before dehiscence, in both specific and interspecific hand-pollinations, fruit setting was very successful. In *A. muricata,* however, proterandry seems to be a characteristic.

Morong in 1892 (Wester, 1910) considered the stamens and pistils synchronous in *A. cornifolia* St. Hil., but Wester (1910) found Morong's conclusion to be incorrect, and expressed the belief that the flower of this particular species might have been dichogamous. The experience of Wester convinced him that *A. muricata* can not be successfully crossed with either *A. cherimolia, A. reticulata* or *A. squamosa.*

Organography. In both species under study the order of the development of their floral organs is centripetal. The youngest stage obtained by the writer in *A. squamosa* is shown in plate 1, figure 2, where the lateral floral primordium exhibits its well differentiated calyx lobes. The next to be formed after the sepals on the floral primordium are the three petals, which appear as three humps of cells arranged in a single whorl, each hump alternating with a sepal. These petals grow upward for a while, and then bend inward, thus covering the floral axis (pl. 1, fig. 1-2). The calyx lobes which form the first floral envelopes are outgrown by the petals which permanently protect the internal organs of the flower until anthesis. On the central axis of the floral primordium appear the stamens and the carpels, respectively, in acropetal succession. The stamens are the first to differentiate, appearing as rounded humps of cells from the periphery of the receptacle (pl. 1, fig. 3); their formation is limited to only about half of this enlarged receptacle or torus to the floral primordium. The last floral organs to be developed are the carpels or pistils (pl. 1, fig. 4). The pistils are formed at the central portion of the receptacle, and these start to grow upward, and very early form their ovaries, styles and stigmas (pl. 1, fig. 5-7). The stamens and ovaries are free from each other when young, the former cohering by their connectives later, while the latter fuse on their sides to form the syncarpium.

The development of the floral organs of *A. muricata* is very similar to that of the species named above, and these arise as follows: calyx, outer petals, inner petals, stamens and carpels (pl. 2, fig. 16-19).

MEGASPORANGE

Soon after the carpel has completely formed its style, stigma and ovary, then its infolding basal portion begins to grow and develop at first a conical, then a tubular projection inside the locule of the young ovary (pl. 1, fig. 5-6; pl. 2, fig. 20). This mass of meristematic cells forms the rudimentary nucellus to the nascent megasporange, which is atropous, but due to its early unequal growth, it bends downward, carrying its micropyle away from the stigma (pl. 2, fig. 21). The megasporange is bitegumentary, and the integuments arise in acropetal succession in both species.

Megaspore mother cell. The megasporange becomes completely anatropous long after the archesporial cell is fully differentiated on its nucellus, at which time the integuments are fairly visible. The archesporial cell in both species functions direct as the megaspore mother cell. In *A. squamosa* this is deep-seated (pl. 1, fig. 8) usually appearing at the third or even fourth layer of cells below the epidermis of the nucellus. In *A. muricata,* however, the megaspore mother cell is not so deep-seated as in the former species; it usually differentiates at the second layer of cells below the nucellar epidermis (pl. 2, fig. 22-23). The writer was not able to find more than one megaspore mother cell differentiating in the nucellus of the megasporange of *A. squamosa;* two megaspore mother cells are, however, not uncommonly encountered in megasporanges of *A. muricata.* These megaspore mother cells usually lie side by side, (pl. 2, fig. 22) or one just over the other (pl. 2, fig. 23).

The megaspore mother cells are easily discerned from the rest of the nucellar cells by their large size and affinity for stains. Their nuclei are usually large, and the cytoplasm dense.

In *A. cherimolia,* Nicolasi-Roncanti in 1905 (Schnarf, 1929) observed a single archesporial cell which gives rise to parietal tissue; this observation was corroborated by Herms in 1907 in *Asimia triloba.* In *Cananga odorata,* Oes in 1914 reported that the archesporial cell lies in the middle of the nucellar tissue, usually differentiating at the fourth layer. From the drawings of these authors, Schnarf (1929) is inclined to believe it is not improbable that the archesporium is derived from a subepidermal cell of the nucellus. In *A. muricata* as well as in *A. squamosa,* the archesporial cell is undoubtedly hypodermal in origin, and never divides to form any parietal cell. In fact, in hundreds of slides examined by the writer, there was only one instance (pl. 2, fig. 23) in *A. muricata,* where two archesporial cells were formed in a row below the epidermis of the nucellus, simulating what may be taken as a formation of a primary parietal cell arising from the first division of one archesporial cell. The writer is inclined to believe that if the archesporial cell normally gives rise to a primary parietal cell, several cases similar to that shown in figure 23 of plate 2 would have been encountered. However, if these particular cells are really potentially the daughter cells resulting from the first division of the archesporial cell, this behavior of the archesporium in *A. muricata* may be considered an extreme exception to the normal course of events, rather than the rule. In other words, the behavior of the archesporium observed by the writer in the two species of *Anona* under study is similar to that reported by Oes in 1914 for *Cananga odorata,* and not as has been reported in other species of *Anona. Asimia* and other genera of the family Anonaceae, which feature is considered by Schnarf (1931) as characteristic of this family.

As the megasporange reaches its full mature anatropous condition, the megaspore mother cell greatly enlarges and elongation rather than increase in breadth takes place. In *A. muricata,* the megaspore mother cell becomes wedge-shaped, and completely destroys the single layer of nucellar cells below it, thus directly abutting the nucellar epidermis (pl. 2, fig. 24). In *A. squamosa,* destruction of the nucellar tissue is not so great, so that the embryo sac very seldom abuts the nucellar epidermis. As is normally the case, the megaspore mother cell by two successive divisions gives rise to four megaspores or tetrads.

Megaspores. Based on the arrangement of the tetrads observed in *A. squamosa,* division of the megaspore mother cell is not uniform. In this species, the writer finds the first division of the mother cell is transverse, the micropylar daughter megaspore of the dyad dividing longitudinally or vertically (pl. 1, fig. 9), while its chalazal daughter megaspore cell divides transversely. However, the usual linear arrangement of the tetrads is commonly met with in both species (pl. 1, fig. 10-12), except in a very few cases in the species cited above.

Megagametophyte. The megaspores do not remain inactive a long while, as enlargement of the chalazal megaspore usually follows their formation. The chalazal megaspore functions as the embryo sac (pl. 1, fig. 9-10); sometimes the third megaspore may exhibit more active enlargement compared with its sister megaspores (pl.

1, fig. 11). In very rare cases the third and fourth megaspore may also show a similar rate of enlargement (pl. 1, fig. 12). In a majority of cases the innermost megaspore functions and gives rise to the normal embryo sac. Normal development of the embryo sac has also been reported in *Asimia triloba* by Herms in 1907, and in *Cananga odorata* by Oes in 1914 (Schürhoff, 1926, and Schnarf, 1929).

A very interesting occurrence of two embryo sacs (pl. 2, fig. 25) which lie side by side in a single megasporange in *A. muricata* was noted by the writer. The formation of two sacs may be readily explained in the light of what has been observed in the behavior of the megaspores in *A. squamosa* (pl. 1, fig. 12), where the third and fourth megaspores exhibit a more or less sliding growth during their enlargement, their nuclei then dividing, and independently giving rise to the two contiguous embryo sacs in *A. muricata.* This phenomenon is rather rare in occurrence, and embryo sacs derived from two megaspores seldom reach maturity. In figure 25, plate 2, the wall separating the two embryo sacs seems to be undergoing disintegration, so there is a chance for their contents to fuse. Fusion of adjacent embryo sacs of varied origin have been reported in many species (Schnarf, 1929).

Division of the nucleus of the functional megaspore is normal, that is, by three successive divisions of this nucleus (pl. 1, fig. 13-15; pl. 2, fig. 26), a normal seven-celled megagametophyte, so often encountered in Angiosperms, is formed (pl. 3, fig. 27).

The mature embryo sac of *A. muricata* (pl. 3, fig. 27) shows a distinct egg apparatus, two polar nuclei, and antipodals. The egg apparatus occupies the micropylar end of the sac. The synergids are more or less obovate, with their smaller ends directed towards the micropyle; in each synergid is found a dense cytoplasm, thickest at its micropylar portion, vacuolated at its distal end; a distinct, heavily stained nucleus is found embedded in the cytoplasm. Lying behind and between the synergids is the megagamete which is much vacuolated at its micropylar end, its cytoplasm being confined mostly in its distal portion wherein is found its well developed nucleus. Lying against the wall of the sac is the thin cytoplasm, but thickest at each end. Adjacent to the lateral wall of the sac and lying in a mass of cytoplasm are the two polar nuclei. These are rounded to oblong in shape.

At the extreme chalazal end of the sac are the antipodals. Distinct walls enclose each of them and their nuclei undergo degeneration. Only two of the three antipodals persist here, and in all probability they are actually disorganizing, thus confirming the statement of Schnarf (1931) that antipodals of Anonaceae are ephemeral in nature. In other genera of this family, three antipodal cells have also been reported by Nicolasi-Roncanti in 1904, Herms in 1907, and Oes in 1914 (Schnarf, 1929).

MICROSPORANGE AND MICROSPORE

The stamens of *A. squamosa* are the first reproductive organs to differentiate on the enlarged receptacle of the floral primordium (pl. 1, fig. 3; pl. 2, fig. 18-19), as club-shaped structures which elongate upward, and very early form their short filaments and elongated anthers. In a transverse section the young anther is at first rounded; soon becomes four-angled, each angle forming a distinct microsporange. The whole anther has a distinct epidermal layer enclosing a mass of meristematic, isodiametric homogeneous cells. Simultaneously, with the formation of the angles, a central vascular bundle in the connective of the anther becomes evident.

Long after the microsporanges are well marked, the microspore mother cells differentiate at the central portion of the sporange (pl. 3, fig. 28). The microspore mother cells are arranged in a single row throughout the length of the anther, each of which is separated by distinct sterile tissue (pl. 3, fig. 29), a feature true of many of the representatives of this family. These mother cells are large, polygonal in transverse section, and radially elongated in longitudinal section.

Further development of the microspore mother cell is shown by its enlargement, and later this rounds off and becomes ovoid (pl. 3, fig. 30). Soon, it enters synapsis, and by two successive divisions the tetrads of the typical monocotyledonous type are formed. The microspores become separated by simple furrowing which takes place some time before the completion of the second division of the mother cell (pl. 3, fig. 31-32).

Division of the microspore mother cell in the family Anonaceae has been the subject of much dispute and controversy. In *Anona cherimolia*, for example, Samuelson in 1914 (Schnarf, 1929) reported simultaneous division of the microspore mother cell, whereas successive division has been observed in *Cananga odorata* and *Asimia triloba* by Oes in 1914 and Herms in 1907, respectively. Schnarf (1931) believes that simultaneous division of the mother cell is the rule in this family, and that the results reported for *Cananga odorata* and *Asimia triloba* are doubtful, as accounts for these two species are rather vague (Schnarf, 1929). Schürhoff (1926), on the other hand, gives successive division of the mother cell as typical of the family, his statement being based also on the reports of Oes in 1914 and Herms in 1907. In the course of his discussion, however, Schnarf admits that the division of the mother cell in *Magnolia* and *Anona cherimolia* belongs to what he terms "modified simultaneous division," because of the fact that furrowing is belated and takes place only before the completion of the second division of the nucleus of the mother cell. In short, this division referred to is intermediate between what have been considered true simultaneous and successive divisions. The writer agrees with Schürhoff (1926) that this division is successive inasmuch as complete separation of the dyad takes place before their nuclei were able to complete the homotypic division. In *Anona squamosa,* furrowing begins some time before or at the initiation of the homotypic division (pl. 3, fig. 31) and this is completed some time before the completion of this division (pl. 3, fig. 32). At the time furrowing has gained momentum, the nuclei of the dyad are in the prophase stage of the homotypic division, and this furrowing is completed only when the nuclei of the dyads are in the metaphase stage of the homotypic division.

The tetrads are liberated soon after the complete dissolution of the walls of the mother cell and these are then uninucleate (pl. 3, fig. 33). Coulter and Chamberlain (1903) report that microspores cling together, as in *Typha,* in certain orchids (as *Neottia*), *Anona, Foucroya,* and *Rhododendron.* Such a condition among the young or the mature microspores in this species of *Anona* has never been observed by the writer.

The young microspores possess a well developed thick wall at the region farther from the zone of contact with its sister microspores after separation, but after a while it acquires its own distinct coats, the exine and intine (pl. 3, fig. 34-36). The exine seems not to develop equally well and uniformly throughout the surface of the microspore, and this coat is sometimes faintly discernible at the region at which the microspore is attached to its sister cells. The coats show the characteristic radial striations across them. Long before dehiscence, its nucleus divides (pl. 3, fig. 34) and gives rise to two unequal daughter nuclei, one of which becomes the vegetative nucleus and the other, the generative nucleus (pl. 3, fig. 35). The vegetative nucleus, which is the larger of the two, is ovoid and possesses deeply stained nucleoli. The generative nucleus is much smaller than the vegetative, and is oblong, with larger nucleolus. Later, cytokinesis cuts off the generative nucleus (pl. 3, fig. 36) from the vegetative nucleus, and the former usually lies at one side of the microspore adjacent to the coat.

The sterile tissue surrounding the microspore mother cells forms the nutritive tissue or tapetum, during the development of the microspores. The cells of this sterile tissue directly abutting the microspore mother cells are at first uninucleate, but by the time the mother cells have entered synapsis, their nuclei have divided and the tapetal cells become binucleate. Later, their walls as well as those of adjacent cells disappear, and their contents form the characteristic periplasmodium in which numerous free nuclei float. This periplasmodium, however, disappears some time before the anthers reach maturity.

At maturity of the anther, the greater portion of the parietal tissue disappears. Its epidermal cells become markedly flattened tangentially, while the outermost layer of cells of the parietal tissue, the endothecium, remains as rectangular cells with thickened walls, devoid of the characteristic rod-shaped thickenings so peculiar to endothecial cells of other species of Angiosperms. Below the endothecium. some cells of the parietal tissue may remain attached to the wall of the anther (pl. 3, fig. 37).

SUMMARY

The development of the floral organs and gametophytes of *Anona squamosa* Linn. and *Anona muricata* Linn. is herein reported. Dehiscence and anthesis in the latter species are not synchronous, and its flower is proterandrous.

The sequence of appearance of the floral organs for these two species is centripetal.

The megasporanges in both species are anatropous. Generally a single-celled archesporium which functions as the megaspore mother cell differentiates in the nucellus. However, the development of more than one megaspore mother cell in *A. muricata* is not uncommon. A linear tetrad of four megaspores is developed, the innermost of which gives rise to the normal embryo sac. Development of two embryo sacs has been observed in *A. muricata*.

A single row of microspore mother cells is formed in the microsporange of *A. squamosa*. Separating each mother cell is a sterile tissue, which functions as the tapetum. Division of the microspore mother cell is successive, and the microspores become separated by simple furrowing. The young microspores are uninucleate, later becoming invested with distinct coats which are beautifully striated radially. Before dehiscence, the microspore becomes binucleate, and later, by cytokinesis, it becomes two-celled.

The tapetal cells are at first uninucleate, and later, become binucleate. The formation of periplasmodium which disappears long before dehiscence has been observed.

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EXPLANATION OF PLATES

Parts of the flowers have been designated as follows: antipodals (*an*), bract (*br*), carpel or pistil (*c*), endothecium (*en*), epidermis (*ep*), generative cell (*gc*), generative nucleus (*gn*), inner petal (*ip*), megasporange or ovule (*m*), megagamete or egg (*me*), outer petal (*op*), petal (*p*), polar nuclei (*pn*), sepal (*s*), stamens (*st*), synergid (*sy*), vegetative cell (*vc*), and vegetative nucleus (*vn*).

Plate I. Anona squamosa Linn.

Fig. 1. Longitudinal section of a young floral primordium showing calyx and corolla already differentiated. × 28.

Fig. 2. Longitudinal section of a floral cluster showing an apical flower with its perianth fully formed, and a lateral one with its calyx on. × 28.

Fig. 3. Floral axis showing the beginnings of the stamens. × 58.

Fig. 4. Longitudinal section of an older flower with stamen and carpel primordia. × 28.

Fig. 5. Longitudinal section of a single carpel with a juvenile basal megasporange. × 58.

Fig. 6. Transverse section of the ovary showing its placenta and a young megasporange. × 58.

Fig. 7. Transverse section of the style (diagram). × 58.

Fig. 8. Nucellus of a megasporange showing the megaspore mother cell in synapsis; integuments fully formed. × 540.

Fig. 9. Tetrads; micropylar megaspore daughter cell of the dyad has divided vertically while its chalazal sister cell transversely; chalazal megaspore functional. × 1060.

Fig 10. Tetrads; chalazal megaspore functional. × 1060.

Fig. 11. Tetrads; third megaspore from the micropyle showing activity. × 1060.

Fig. 12. Tetrads; two inner megaspores enlarging. × 1060.

Fig. 13. Binucleate megagametophyte; both daughter nuclei at chalazal end of the sac. × 540.

Fig. 14. Binucleate megagametophyte; daughter nuclei at center of the sac. × 540.

Fig. 15. Quadrinucleate megagametophyte showing distinct polarity. × 1060.

Plate II. Anona muricata Linn.

Fig. 16. Longitudinal section of a single flower showing its calyx and outer petals. × 28.

Fig. 17. A much older flower showing formation of stamens; outer and inner petals well developed. × 28.

Fig. 18. A still older flower showing all stamens already differentiated; carpels beginning to develop. × 28.

Fig. 19. Same as fig. 19, but more advanced. × 28.

Fig. 20. Transverse section of an ovary showing placenta and a young megasporange. × 54.

Fig. 21. Longitudinal section of a carpel showing its style, stigma and ovary with a single megasporange having its integuments fully differentiated. × 28.

Fig. 22. Nucellus of a megasporange showing two megaspore mother cells lying side by side; note the outer integument. × 540.

Fig. 23. Nucellus of another megasporange showing two megaspore mother cells lying in a row. × 540.

Fig. 24. Megaspore mother cell in synapsis. × 540.

Fig. 25. Two megagametophytes from a single megasporange arising from two chalazal megaspores. × 540.

Fig. 26. Octonucleate megagametophyte; a nucleus missing. × 890.

Plate III. Anona muricata Linn. *and Anona squamosa.* Linn.

Fig. 27. Mature megagametophyte of *Anona muricata.* ×890.

Fig. 28. Transverse section of a microsporange of *Anona squamosa* Linn. showing microspore mother cell in resting condition. × 1060.

Fig. 29. Longitudinal section of the microsporange showing arrangement of microspore mother cells in resting condition; note the sterile tissue between the mother cells. × 890.

Fig. 30. Microspore mother cell in synapsis. × 1060.

Fig. 31. Dyad in prophase stage of the homotypic division; note the furrowing of the cytoplasm of the daughter cells. × 1060.

Fig. 32. Dyad in metaphase stage of the homotypic division; daughter cells already separated by furrowing. × 1060.

Fig. 33. A young microspore after separation. ×1060.

Fig. 34. Showing division of the nucleus of the microspore; note the characteristic striation of the coats. × 1060.

Fig. 35. Microspore showing daughter nuclei resulting from the division of its nucleus. × 1060.

Fig. 36. Microspore with its vegetative and generative cells fully differentiated. × 1060.

Fig. 37. Longitudinal section of a portion of the anther showing its epidermis, endothecium and remains of its parietal tissue. × 1060.

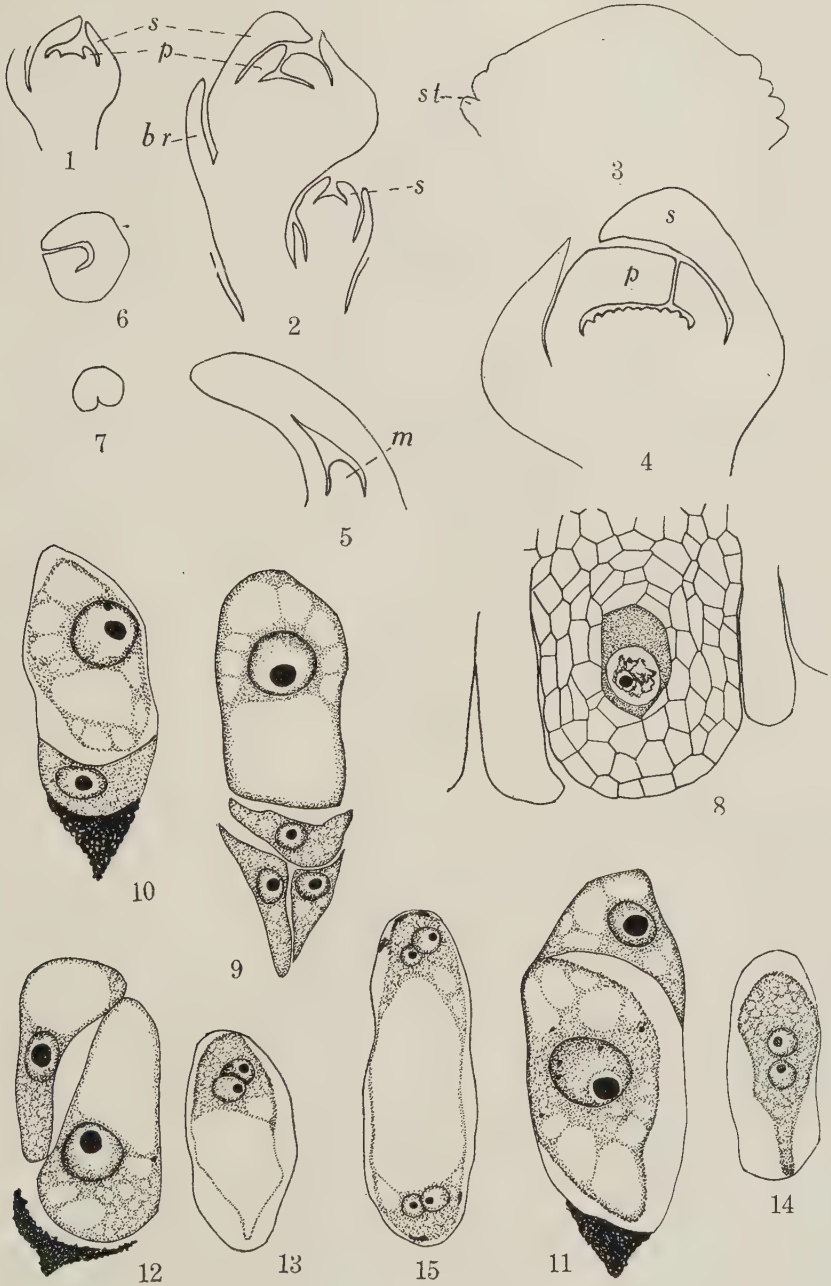
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PLATE I

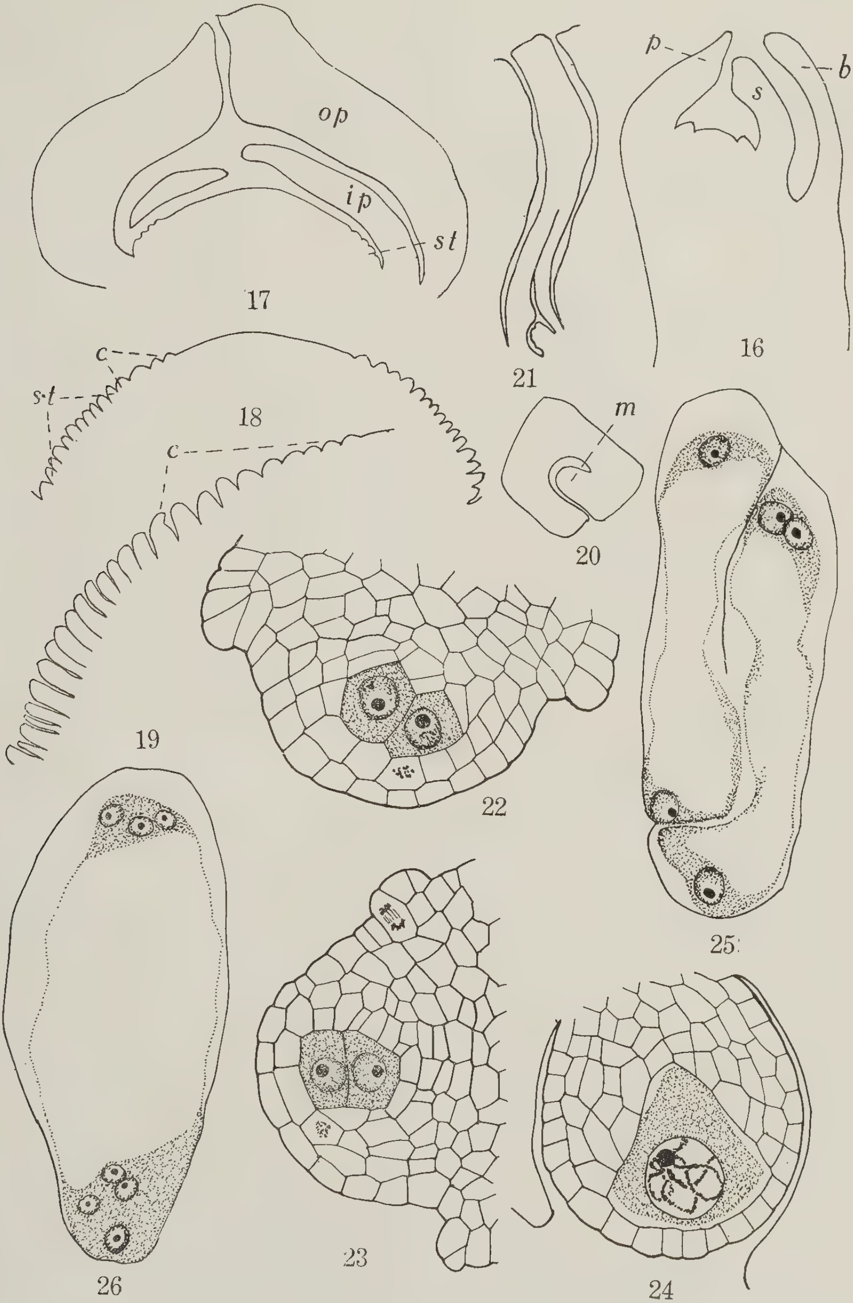
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PLATE II

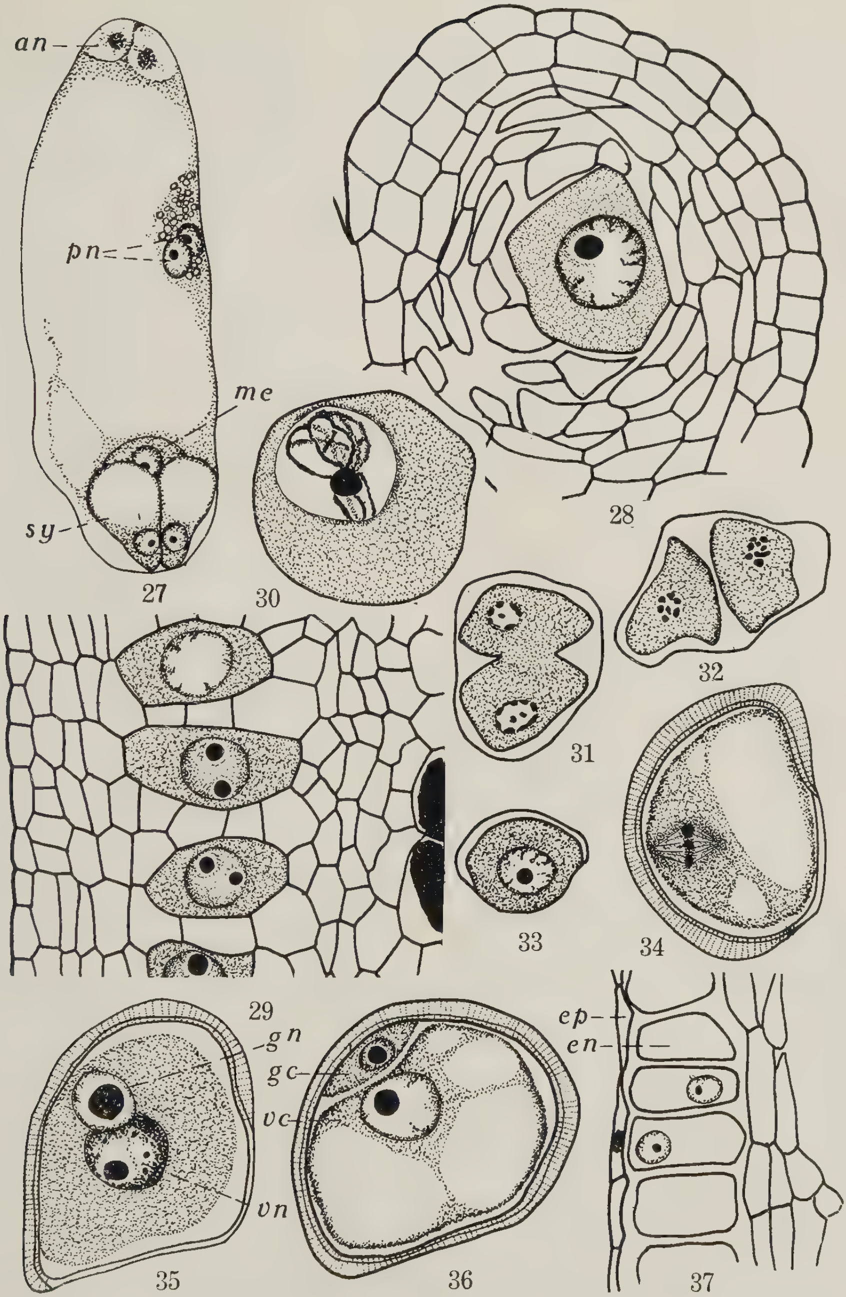
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PLATE III

COMPARATIVE COST OF OPERATION OF A FORDSON TRACTOR USING KEROSENE AND ALCOHOL AS MOTOR FUELS[1]

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WITH ONE TEXT FIGURE

Several tests have been conducted under this department on the use of alcohol or alcohol mixtures as fuel for tractors and other engines that were originally designed for gasoline or for kerosene. All of these tests showed favorable results on the suitability of alcohol for these engines when slight modifications were made on their original construction. The majority of these tests were conducted in the laboratory where factors that would contribute to the variability in the consumption of the fuel are under the control of the experimenter. In the laboratory, the speed, or r.p.m. of the engine and the load applied can be controlled. In the field these factors, careful as the worker may be, can not be made constant owing to the variable field conditions, such as topography of the land and soil conditions. It is, therefore, an important problem to compare under actual field conditions the fuel consumption and engine performance using alcohol and kerosene as fuels.

There are a number of investigators who have conducted tests comparing alcohol or alcohol mixtures as fuel with other fuels, such as gasoline, kerosene and crude oil.

The following workers carried tests using alcohol or alcohol mixtures as fuel on various makes of engines:

Luke and Woodward (1907) made extensive tests on internal combustion engines. Strong and Stone (1918) used single cylinder engines. Ricardo (1921-1922) ran tests on a variable compression engine of his own make. Teodoro (1931) conducted belt tests on multi-cylinder tractor engines; Teodoro and Banzon (1932) on McCormick-Deering Industrial Power Unit Model 300. Cruz and Ang (1932) used small gas engines ranging from 1-1/2 to 6 H.P.

All these tests proved that engines which were originally designed to use either gasoline or kerosene as fuel could, with slight modification, be run on alcohol or alcohol mixtures.

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[1] Experiment Station contribution No. 1072. Received for publication July 2, 1935.

The objects of the present study were: (*a*) To determine and compare the fuel consumption of the Fordson tractor using kerosene and alcohol as fuels. (*b*) To compare the oil consumption when kerosene fuel is used and when alcohol fuel is used. (*c*) To compare the cost of field operations using kerosene and alcohol as fuels. (*d*) To study the performance of the engine.

The work was conducted in the Experiment Station fields of the College of Agriculture at Los Baños, Laguna and in the Fuel and Lubricant Laboratory of the Department of Agricultural Engineering, in the same College. The work covered a period of ten months from May, 1934, to February, 1935.

MATERIALS AND METHODS

The tractor and the plow used

Fordson tractor model 1933 and a 2-24 inch disk plow mounted on the right side were used in this work.

According to the manufacturer, the tractor has the following specifications:

Engine—4-1/8″ × 5″, 4-cyl., 267 cu. in. displacement. 30 B.H.P. at 1000 R.P.M. with gasoline fuel and 77 lb. compression. 26 B.H.P. at 1000 R.P.M. with kerosene fuel and 67 lb. compression. Crankshaft hardened, and carefully balanced. Pistons—light weight, die cast iron—5-1/16″ long, 4 piston rings used 5/32″ wide. Three main bearings 2″ dia. × 3″ long. Connecting rod—9-1/2″ long—lower bearing 2″ dia. × 2-1/4″ long. Kerosene vaporizer 1-1/4″ Kingston Hot Plate type. Gasoline carburetor 1-1/4″ Zenith down draft hot spot manifold. Valves, chrome silicon alloy steel, 1-3/4″ dia., stems 11/32″ dia.

Cooling—Centrifugal pump, 18″ diameter 4-blade fan; tube radiator, capacity 11-1/2 gal.

Ignition—High tension magneto, impulse coupling. Manual spark advance. Automatic retard for cranking. Spark plugs 7/8″ S.A.E.

Lubrication—Circulating splash. Flywheel pump. 7″ filter screen. Oil capacity 2-1/2 gal.

Air washer—Water type with float. Integral with dash. Capacity 17 quarts.

Clutch—Multi disc in oil. 17 hardened plates. Lever provided for holding in release position.

Transmission—Three-speed and reverse. Constant mesh. Internal gear clutch for each speed. Heavy duty straight roller bearings. Gears 5–7 pitch chrome alloy steel.

Steering—Enclosed bevel pinion and sector. 18″ dia. rubber covered steel steering wheel. Turning circle 21 feet.

Fuel tank—Capacity 20 gal. Reserve tank 5 quarts. Two-way valve with strainer and sediment chamber.

Front axle—Heat treated steel I-beam forging.

Front spring—Helical type mounted at center of axle.

Rear axle—Semi-floating worm drive. Worm hardened and ground and mounted at each end on double roller bearings. Phosphor bronze wheel. Ratio 17 to 1. Axle shaft 2″ dia. high carbon steel hardened and ground.

Brake—Multiple disc on transmission. 16 hardened plates. Operated by clutch pedal.

Front wheels—Cast iron 30″ dia. × 5″ wide. Taper roller bearings.

Rear wheels—Steel, 42″ dia. × 12″ wide, 14 angle cleats 3″ high. 7″ extension rims extra. Straight roller bearings lubricated from worm housing.

Fenders—Heavy gauge steel, braced at 6 points, includes platform and tool box.

Weight—Fully serviced 3310 lb. Front—1360. Rear—1950 lb.

Fuels used

Kerosene. The kerosene used has a specific gravity of 0.8170 at 15°C.

Alcohol. The alcohol fuel used came from the distilleries of the Calamba Sugar Estate. It is the fuel known as special Alkohl motor fuel with a specific gravity of 0.8255 at 15°C.

Gasoline. Gasoline was used in starting the engine when kerosene was used as fuel.

Other equipment used

A graduated cylinder 2000 ml. in capacity was used to measure volumes; a 25-foot tape to measure distances; a stopwatch to measure time in seconds; an electric oven to dry soil samples and oil dilution apparatus to determine the dilution of the used oil.

Procedure of tests

A Fordson tractor was lent to the Department of Agricultural Engineering by the Manila Trading and Supply Company. As the engine was new, it was broken-in before it was used in the tests.

Carburetor adjustment. After starting the engine on gasoline and letting it run for about three minutes, the two-way valve was shifted to kerosene. The flow of kerosene was partially cut off by screwing the fuel needle valve down until the engine began to misfire. As soon as misfiring was noticed the fuel needle valve was gradually screwed up thereby increasing the kerosene supply until the engine reached its highest speed and no smoke was noticed from the exhaust with the air valve fully open and spark fully advanced. The number of turns of the fuel needle valve was noted and found to be 1-7/8. This adjustment was maintained throughout the tests. After the tests using kerosene as fuel, the performance of the engine was observed with the same carburetor adjustment but using alcohol as fuel. It was found that the same adjustment worked satisfactorily on alcohol.

In all of the trials made the throttle-governor control was kept at the same notch, the fifteenth from the outer end. At this throttle opening, the tractor gave a plowing speed of from 2.5 to 3 miles an hour.

Determination of fuel consumption. Before the test was made the fuel tank was carefully filled up to a certain reference mark at the filler neck of the fuel tank. The tractor was then used for plowing. After the day's work the fuel tank was again filled to the full mark, noting the amount used in filling. This amount was considered as the fuel consumption for the area plowed. The plowed field was measured after each day's operation. The time of starting the operation was noted and also the time when it was finished. From these data, fuel consumption in liters per hour, liters per hectare, gallons per hour and gallons per hectare were computed. Each day-test was considered a trial. There were fourteen day-tests for each fuel; hence fourteen trials were averaged for each fuel.

Oil consumption. The amount of oil placed in the crank case before the test of each fuel was measured. After about 48 hours of use, the amount of used oil in the crank case was again measured. The used oil was a mixture of oil and fuel as a result of dilution. The percentage of dilution was determined; and the actual amount of oil in the mixture was then computed. The difference between the amount of new oil placed before the test and the computed actual amount of oil after the test was the consumption.

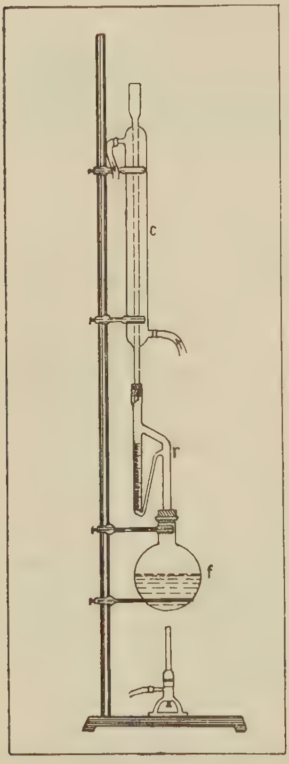

Fig. 1.—Oil dilution testing apparatus: *f*, 1000 ml. flask containing 500 ml. water and 25 ml. test oil; *r*, special receiver; *c*, reflux condenser.

Measuring the percentage of oil dilution. Dilution was determined by the A.S.T.M. method, D322-30T. Briefly, the method is as follows: (see figure 1). Five hundred ml. of water were placed in the flask *f* and to it 25 ml. of the oil sample were added. The mouth of the flask was connected to a special receiver *r*. The other end of the receiver was connected to a reflux condenser *c* cooled by tap water. The flask was then heated with a regulated Bunsen burner flame in such a way that the water began to boil in from 7 to 10 minutes. The diluent, but not the oil, went with the steam and the reflux back to the receiver. Owing to a higher specific gravity, the condensed water fell to the bottom of the receiver and flowed slowly back to the flask through a small tube. The diluent having a lower specific gravity became the upper layer and remained trapped in the graduated receiver. The volume was then read off directly. Readings were taken every 15 minutes for low dilutions and every 30 minutes for high dilutions. When the volume of the diluent caught did not increase more than 0.1 ml. in a 15-minute interval the test was considered complete. The final reading of the diluent was taken at room temperature. This reading when multiplied by four gives the percentage of dilution, because the amount of oil used was 25 ml. or one-fourth of 100.

Water consumption. The water used up in the radiator during each day-test was also determined. The method of determining the quantity is the same as the method used in determining fuel consumption.

Soil moisture. The moisture of the soil during the time of plowing was determined. Samples from different parts of the field were taken at random. A known weight of the sample was dried in an electric oven to a constant weight. The percentage of moisture in the soil was thus determined.

Plowing adjustment. In all of the trials made the lever controlling the depth of plowing was locked at a fixed notch. The notch used gave a plowing depth of from 6 to 8 inches.

EXPERIMENT AND RESULTS

The results of this experiment are presented in tables 1 to 4. Table 1 shows the consumption of kerosene, gasoline and water when kerosene was used as fuel. It may be observed from this table that the time required to plow one hectare of land was 7.21 ± 0.0683 hours; kerosene consumption, 1.97 ± 0.0156 gallons per hour or 14.35 ± 0.1671 gallons per hectare; and gasoline as starting fuel, 0.35 ± 0.0179 gallon per hectare. The moisture content of the soil on the day of plowing is also shown in the same table. During the 14-day test for kerosene a total of 9.7372 hectares were plowed.

Table 2 shows results obtained when alcohol was used as fuel. The time required to plow one hectare was 7.84 ± 0.0788 hours; and alcohol consumption, 2.11 ± 0.0226 per hour or 16.45 ± 0.1885 gallons per hectare. The table also shows the moisture content of the soil on the day of plowing. A total of 6.0876 hectares were plowed during the 14-day test for this fuel.

Table 3 shows the oil dilution and consumption using kerosene and alcohol as fuels. For kerosene, the oil dilution after about 48 hours of use was 32 per cent. The computed consumption was 1,635 ml.

When alcohol was used as fuel the oil dilution after about 48 hours of use was 3.8 per cent and the computed consumption was 34.8 ml.

Table 4 shows the itemized cost in plowing one hectare of land. The total cost was ₱8.64 per hectare when kerosene was used as fuel and ₱7.37 when alcohol. The following computations shows how the itemized costs were obtained:

Kerosene: per hectare:

(1) Cost of fuel = 14.35 gal. × ₱0.38 .... ₱5.45

(2) Cost of gasoline = 0.35 gal. × ₱0.53 .... 0.19

(3) Cost of oil = $\frac{9 \times 7.21 \times \text{₱}0.25}{50}$ 0.32

(The oil used was 9 liters at ₱0.25 a liter. It was used for 50 hours. The duration for plowing a hectare was 7.24 hours.)

(4) Depreciation of tractor and plow

$\frac{2100 \times 7.21}{8 \times 140 \times 9}$ 1.50

(The tractor and plow cost ₱2100. Their life is 8 years and the average number of working days during the year is 140 days at 9 working hours a day.)

(5) Interest on the cost of the tractor and plow at 10 per cent per annum

$\frac{2100 \times 7.21 \times 0.10}{365 \times 9}$ 0.46

(6) Cost of man labor at ₱0.10 an hour = 7.21 × ₱0.10 . 0.72

Total cost of operation .... ₱8.64

The same method of calculation was followed for alcohol.

In computing the charges for the use of the tractor with the side mounted plow the following formulas by Catambay (1931) were used:

$$\text{Depreciation in pesos} = \frac{cd}{ym}$$

$$\text{Interest in pesos} = \frac{crd}{365}$$

where c = cost of implement or machinery
d = number of 9-hour days used
m = maximum number of days used in one year
y = number of years of life of the implement or machinery
r = annual rate of interest

DISCUSSION OF RESULTS

Fuel consumption

Tables 1 and 2 show the time required to plow a hectare, the data on fuel consumption in gallons per hour and gallons per hectare.

The time for plowing a hectare field when kerosene was used ranged between 6.43 and 7.97 hours, with a mean of 7.21 ± 0.0688 hours. When alcohol was used the range was between 6.97 and 8.58 hours with a mean of 7.84 ± 0.0788 hours. The results show that the tractor was a little slower when alcohol was used. One possible explanation of this persistent slow speed when alcohol was the fuel with the jet opening the same as that for kerosene was that the power developed by alcohol was not as much as the power developed by kerosene for the same load.

The fuel consumption of kerosene was 1.97 ± 0.0156 gallons per hour or 14.35 ± 0.1702 gallons per hectare; of alcohol 2.11 ± 0.0217 gallons per hour or 16.45 ± 0.1837 gallons per hectare. These results show that it takes 1.15 times as much alcohol by volume as that of kerosene to plow the same area.

In this comparison, it should be noted that the field conditions, that is—topography of the land, soil moisture and soil texture, were about the same. See tables 1 and 2 for data on soil moisture. All the fields were practically flat and the soil was clay loam.

Oil consumption

Table 3 shows the data on dilution. The dilution of the oil when kerosene was the fuel was determined and found to be 32 per cent. This high percentage explains why the oil obtained after the test was more in quantity than that of the oil which had originally been placed in the crank case. The quantity of used oil was 10,830 ml. as compared with 9,000 ml. of the original oil. Thirty-two per cent of 10,830 ml. is 3,465.6 ml., the computed amount of diluent or kerosene in the oil. Hence, the amount of supposedly pure oil in the mixture was 7,364.4 ml. Thus, the oil consumption was 1,635.6 ml., which is the difference between 9,000 ml. and 7,364.4 ml.

The dilution of the oil when alcohol was the fuel was 3.8 per cent. Theoretically, the dilution of the oil when alcohol is the diluent can not be measured with the present method of determination, as alcohol and water do not separate. The percentage obtained in the test was caused by the kerosene used as denaturant in the special Alkohl motor fuel. It is seen, therefore, that the percentage of 3.8 was not the true percentage of dilution of the oil.

In the discussion given above, it is shown that it would not be fair to either fuel to make comparisons on the consumption of oil. It was found, however, that there was dilution of the oil in each case.

Cost of plowing per hectare

Table 1 shows that to plow one hectare of land 14.35 gallons of kerosene were used; table 2, that to plow the same area, 16.45 gallons of alcohol were required. At the present price of kerosene ₱0.38 a gallon, the cost of fuel per hectare was ₱5.64, including ₱0.19 for gasoline used for starting. At the present price of alcohol, ₱0.25 per gallon, the cost of fuel per hectare is ₱4.11. Hence, in fuel alone, there is a saving of ₱1.53 per hectare when alcohol fuel is used.

In comparing the costs of the two fuels, the question comes up; what should be the maximum cost of alcohol per gallon in order to operate the tractor at the same fuel cost as when kerosene is used? In fuel consumption it takes 1.15 times as much alcohol as kerosene to plow the same area; hence the alcohol cost is really ₱0.38 divided by 1.15 or ₱0.33 a gallon. In other words, if the cost of kerosene is unity, the cost of alcohol should be 0.87 times the cost of kerosene.

Table 4 shows the total cost of plowing one hectare of land. When the costs of all the items in the field operation are considered, the cost of plowing one hectare when kerosene was the fuel was ₱8.64, and when alcohol, ₱7.37. The cost of operating the tractor using alcohol was ₱1.27 less than the cost of operating the same tractor using kerosene.

Behavior of the engine

Starting. The tractor engine can not be started with kerosene, so gasoline was used. As soon as the engine was warmed up, the fuel was shifted to kerosene. The engine could be started with alcohol, but when the weather was cool, the engine would not start as easily as in hot weather.

Flexibility. Whenever a hard spot was encountered in plowing, the engine labored. Under such a condition there was a notable difference in the performance of the engine with the two fuels. With kerosene, it was necessary many times to shift to first gear, the second gear being the gear used in plowing. With alcohol, however, there was no condition in which shifting of gear became necessary. In this respect, alcohol as fuel gave a better performance at heavier load than kerosene.

SUMMARY OF RESULTS

The following were the results obtained in this study:

1. The fuel consumption of kerosene was 14.35 ± 0.1671 gallons per hectare; of alcohol, 16.45 ± 0.1885 gallons per hectare. By volume it took 1.15 times as much alcohol as kerosene to plow the same area.
2. It took 7.21 ± 0.0688 hours to plow a hectare when kerosene was used as fuel and 7.84 ± 0.0788 hours when alcohol was used. This means that there is a saving of 0.63 hour a hectare by using kerosene as fuel.
3. The cost of field operation when kerosene was used as fuel was ₱8.64, and ₱7.37 when alcohol was used. Thus for fuel in plowing one hectare of land alcohol was ₱1.27 cheaper than kerosene.
4. To operate the tractor with alcohol at the same fuel cost as with kerosene, the price of alcohol should be 0.87 times the price of kerosene. The present price of alcohol is 0.66 times the price of kerosene.
5. The tractor can not be started with kerosene but can with alcohol. The engine starts more readily on alcohol in hot weather than in cold.
6. At the heavier loads alcohol fuel gave a better performance than kerosene fuel.

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TABLE 1

Showing kerosene, gasoline and water consumption

DURATION OF TEST	AREA PLOWED	TIME TO PLOW ONE HA.	KEROSENE					GASOLINE [a]			WATER			MOISTURE CONTENT OF SOIL
			Actual	Per hour		Per hectare		Actual	Per hectare		Actual	Per hour		
hr.–min.	*sq. m.*	*hours*	*liters*	*liters*	*gallons*	*liters*	*gallons*	*liters*	*liters*	*gallons*	*liters*	*liters*	*gallons*	*per cent*
6—15	8,800	7.10	44.1	7.06	1.87	50.11	13.24	0.70	0.80	0.21	4.2	0.77	0.20	23.32
6—15	9,020	6.93	46.3	7.41	1.96	51.33	15.56	0.25	0.94	0.25	4.9	0.78	0.21	21.87
6—05	9,299	6.43	49.3	8.11	2.14	53.02	14.01	0.60	0.66	0.17	4.5	0.74	0.20	21.87
6—35	8,580	7.67	49.6	7.54	1.99	57.81	15.27	1.29	1.40	0.37	4.6	0.70	0.18	24.90
5—00	6,664	7.51	36.0	7.20	1.90	54.02	14.27	0.80	1.20	0.32	4.2	0.84	0.22	22.50
7—05	8,875	7.97	54.3	7.67	2.02	61.18	16.16	0.93	1.04	0.27	4.8	0.68	0.18	22.09
3—45	5,096	7.37	30.1	8.02	2.12	59.07	15.61	0.61	1.12	0.29	2.4	0.64	0.17	21.38
7—50	10,504	7.39	56.1	7.16	1.80	53.00	14.00	0.95	0.90	0.24	5.2	0.66	0.17	22.40
3—05	4,416	6.97	22.5	7.30	1.93	50.95	13.46	0.70	1.59	0.42	4.2	1.36	0.36	21.84
2—20	3,200	7.28	18.4	7.85	2.07	57.50	15.19	0.69	1.88	0.59	3.8	1.63	0.43	26.10
5—43	7,728	7.44	39.7	6.90	1.82	51.37	13.57	0.85	1.10	0.29	4.8	0.83	0.22	20.34
2—30	3,580	6.98	17.7	7.08	1.87	49.44	13.06	0.75	2.09	0.55	3.6	1.44	0.38	23.83
4—45	7,020	6.77	38.4	8.08	2.14	54.70	14.45	1.29	1.71	0.45	5.9	1.24	0.32	25.60
3—25	4,510	7.56	24.5	7.18	1.89	54.32	14.35	1.00	2.22	0.59	4.3	1.26	0.33	26.22
Mean	—	7.21±	—	—	1.97±	—	14.35±	—	—	0.35±	—	—	—	—
	—	0.0688	—	—	0.0156	—	0.1671	—	—	0.0179	—	—	—	—

[a] Gasoline is used only to start the engine.

TABLE 2

Showing alcohol and water consumption

DURATION OF TEST	AREA PLOWED	TIME TO PLOW ONE HA.	ALCOHOL					WATER			MOISTURE CONTENT OF THE SOIL
			Actual	Per hour		Per hectare		Actual	Per hour		
hr. - min.	*sq. m.*	*hours*	*liters*	*liters*	*gallons*	*liters*	*gallons*	*liters*	*liters*	*gallons*	*per cent*
2—33	3,420	7.49	18.8	7.27	1.95	54.97	14.52	3.7	1.29	0.342	23.25
2—28	2,880	8.58	18.6	7.55	1.96	64.76	17.10	3.8	1.54	0.404	20.18
3—30	4,416	7.93	29.2	8.34	2.20	66.12	17.46	4.2	1.20	0.316	19.52
2—24	3,240	7.41	21.7	9.04	2.39	67.00	17.30	3.1	1.30	0.341	19.36
5—15	6,486	8.09	42.5	8.09	2.13	65.52	17.31	4.8	0.91	0.240	20.06
2—21	2,970	7.91	16.6	7.06	1.87	55.90	14.77	3.3	1.40	0.370	25.17
4—20	5,400	8.01	22.8	7.81	2.06	62.57	16.53	3.8	0.87	0.229	21.07
5—05	6,060	8.38	40.8	8.03	2.12	67.32	17.78	3.4	0.70	0.180	19.06
4—15	5,670	7.49	34.1	8.02	2.12	60.14	15.86	4.0	0.94	0.248	23.37
1—15	1,794	6.97	10.2	8.16	2.16	56.90	15.00	1.2	0.96	0.254	22.97
3—20	4,050	8.22	27.4	8.22	2.16	67.65	17.86	3.5	1.03	0.282	20.00
2—15	3,036	7.41	18.4	8.18	2.16	60.60	16.00	3.0	1.33	0.382	22.33
6—05	7,590	8.01	47.5	7.81	2.06	62.58	16.53	4.8	0.79	0.218	20.90
3—00	3,864	7.76	23.8	7.93	2.10	61.59	16.00	3.4	1.33	0.380	20.40
Mean	—	7.84±	—	—	2.11±	—	16.45±	—	—	—	—
	—	0.0788	—	—	0.0217	—	0.1885	—	—	—	—

TABLE 3

Showing the dilution and consumption of oil using kerosene and alcohol as fuels

FUEL USED	NEW OIL	DRAINED OIL	DILUTION		COMPUTED CONSUMPTION
	ml.	*ml.*	*per cent*	*ml.*	*ml.*
Kerosene	9,000	10,830	32	3,465.6	1,635.6
Alcohol	9,000	9,320	3.8	354.2	34.8

TABLE 4

Showing the comparison of the cost of operation per hectare using kerosene and alcohol as fuels

ITEMS	KEROSENE	ALCOHOL
	pesos	*pesos*
Cost of fuel	5.45	4.11
Gasoline used for starting	0.19	—
Cost of oil [a]	0.32	0.38
Depreciation of tractor and plow	1.50	1.63
Interest on the cost of tractor and plow	0.46	0.50
Cost of man labor at ₱0.10 per hour	0.72	0.78
Total cost of operation	8.64	7.37

[a] The cost of oil per hectare equals the cost of the oil used divided by the total area in hectares plowed.

PROTEIN SUPPLEMENTS IN POULTRY RATIONS: VI. STUDIES ON THE INFLUENCE OF MUNGO IN RATIONS FOR CHICKS[1]

CLAUDIO N. ADAN

WITH ONE CHART

Mungo is highly recommended for human food because of its high content of proteins and because of its content of vitamin B which is essential for normal growth (Santos, 1922). It is grown extensively in many provinces of the Philippine Islands, notably Pangasinan, La Union, Nueva Ecija, Cavite, and Batangas (Caguicla, 1933). In Pangasinan, La Union and Nueva Ecija mungo can be bought at a price as low as ₱0.15 a ganta or about ₱0.06 a kgm., or possibly even lower.

The Bureau of Animal Industry recommends the use of mungo in rations for baby chicks, for growing chickens and for laying hens. (Burgos, 1932; Miñano, 1933). Because of this recommendation the use of mungo in poultry rations may now be extensively practiced in many places in the Islands. The answers to the following questions, however, will be of timely interest to poultry raisers. (1) In what respect does the addition of mungo in the ration influence the rate of growth of growing chickens; and (2) does it affect the rate of mortality among the chickens? As an attempt to answer these questions, this experiment was conducted.

REVIEW OF LITERATURE

Tuason and Fronda (1924) reported that of the ground feeds that they tested, mungo was third in palatability, shrimp meal being first and fish meal, second. Mungo was made more palatable by adding corn meal, but the mixture was not as palatable as corn meal alone. Thus, mungo, whether used singly or mixed with other feeds, was reported to be fairly palatable.

Cruz (1918) experimenting on the effects of certain Philippine feeds on growth and production of eggs and meat by poultry found that mungo gave the highest total production of eggs, corn, second, and rice the lowest. For feeding chicks the mixed ration gave the highest average growth per chick per week and the lowest percentage of mortality. In fattening experiments with hens, mungo, corn, and rice combined, gave the highest average growth per hen in six weeks. Rodriguez (1923) in a fattening test on capons reported that the capons fed with a ration in which mungo was added to a basal mixture consisting of 15 parts of corn meal and 10 parts of rice bran, by weight, made the second best gain in weight, the basal mixture with copra meal and milk being first, and the addition of copra meal alone to the basal mixture, third.

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[1] A portion of the thesis presented by the author for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 473; Experiment Station contribution No. 1073. Prepared in the Department of Animal Husbandry under the direction of Dr. F. M. Fronda.

The comparative effects of vegetable proteins and animal proteins in rations for poultry have been extensively studied, both in the Philippines and abroad. Only a few of these are reviewed in the following:

Kaupp (1921), Williams (1921) and Kempster and Hervey (1918) found that animal proteins are very much superior to any vegetable proteins as supplements in rations for laying hens. Fronda (1919) reported that with Native hens, snails induced better egg production than copra meal. Goseco (1921) in his experiment with laying ducks found that the lot fed with animal proteins gave higher egg production than the lot fed with vegetable proteins. Moncerate (1922) reported that milk proved to have a better influence upon the growth of chicks than copra meal. Lamon and Lee (1919), experimenting with hens observed that to get a good egg production, the high vegetable proteins could replace only one-fourth to one-half of the meat scraps in the ration.

Comparing meat scraps and soybean proteins when used as supplements to corn for growing chicks for a period of 13 weeks, Philips, Carr and Kennard (1920) observed that an addition of 10 parts of proteins from soybean meal to the basal ration consisting of 50 parts ground corn, 35 parts corn meal, 15 parts corn bran and 3 parts of a specially prepared ash mixture, by weight, gave the best growth, followed by the addition of 10, 15, and 20 parts of protein from the combination of soybean meal and meat scraps. These investigators further concluded that "All the meat scraps rations were found to be somewhat inferior to those of the soybean meal or the combination."

OBJECTS AND TIME AND PLACE OF THE EXPERIMENT

The objects of the experiment which is the subject of this paper were: (*a*) To determine the influence of mungo on the rate of growth of chicks, and (*b*) to observe the effects of mungo on the rate of mortality.

The experiments were conducted in the Poultry Division, Department of Animal Husbandry, College of Agriculture, University of the Philippines, Laguna, from April 16, 1933 to January 31, 1934, covering a period of about 10 months.

MATERIALS AND METHODS

Los Baños Cantonese chicks, all of which were hatched artificially from eggs supplied by the College were used in the experiment. Three sets of these chicks were studied. Each set was divided into three lots all having the same number of chicks. The first set of 180 chicks was run from April 16, 1933 to July 9, 1933, the second set of 180 chicks, from June 12, 1933 to September 4, 1933, and the third set of 120 chicks from August 16 to November 8, 1933. The chicks were properly legbanded and weighed individually before they were taken from the incubator.

Feeding, care and management. The chicks were brooded in fireless brooders that were placed in pens three by four meters. An adjoining yard of three by seven meters was provided in each lot for the chicks to run in for sunshine and for green feeds. At the end of the eighth week the chicks were transferred to portable rearing houses on the range. The chicks in all the sets were self-fed. The mash feed used for each lot during the first 12 weeks consisted of the following ingredients, all parts by weight.

	Lot 1	*Lot 2*	*Lot 3*
Corn meal	2	2	2
Rice bran	6	6	6
Mungo meal	0	1	2
Shrimp meal	2	1	0

The following table shows the proximate analysis of the two protein supplements used in this study. These analyses are from the Department of Agricultural Chemistry.

NUTRIENTS	SHRIMP MEAL	MUNGO MEAL
	per cent	*per cent*
Moisture	14.55	14.70
Ash	19.73	3.01
Protein	55.61	20.44
Crude fiber	4.24	4.36
Nitrogen free extract	3.26	56.56
Fat	2.61	0.93

At the time these experiments were conducted, the feeds used were selling in the local market at the following prices per kilogram:

Rice bran	₱0.036
Corn	0.044
Palay	0.051
Shrimps (dried)	0.121
Mungo	0.100
Copra meal	0.029

All the lots were given finely ground corn meal in the morning and in the afternoon. The mash was made available to the chicks at all times. During the first week of the experiment the corn meal was moistened with egg, mixing one egg a day for every 30 chicks. During the succeeding weeks, up to the eighth, all the lots were given coarsely ground corn. From the end of the eighth week to the twelfth week the grain ration of all the lots was replaced with equal parts of cracked corn and palay by weight.

Records. The individual chicks were weighed weekly from the time that the hatch was taken from the incubator to twelve weeks of age. The chicks that died in each lot were recorded. The feed consumption of each lot was also determined and carefully recorded. Careful observations were made on the health, vigor and activity of the chicks.

RESULTS AND DISCUSSIONS

Growth of chicks. The average weekly weights of chicks in the three lots up to 12 weeks old are shown in table 1. By reference to table 1 and chart 1, it may be seen that in all lots studied the weights of the chicks at the beginning of the experiment were practically the same. From one to three weeks of age the average weights of the chicks in each lot were still practically the same. From the fourth week up to the twelfth week of age, however, differences in the rate of growth between the chicks in each lot may be noticed. It is interesting to note here that in all the three trials studied the shrimp meal fed lot led in growth from the fourth week up to the twelfth week, while the mixed supplement lot was a close second. The mungo meal fed lot was very much behind.

Comparing the chicks of the three lots studied it may be seen that the chicks of the mungo meal lot were very much smaller than those of the shrimp meal lot, or the mixed-supplement lot. The chicks in the mixed-supplement lot were not as uniform in size as those of the shrimp meal lot. Many were stunted in their growth, while there were others that were as large as the birds in the shrimp meal lot.

Treating the figures statistically, the following results were obtained: Lot 1 had a mean of 419.1 ± 34.426 grams; lot 2, 383.8 ± 26.372 grams; lot 3, 154.7 ± 7.159 grams. The difference of the means of lots 1 and 3, 264.4 ± 35.162, shows very significantly that lot 1, the shrimp meal lot was the better. A comparison of the means of the shrimp meal lot and the mixed-supplement lot, however, gave the difference of only 35.3 ± 43.366 which is not significant.

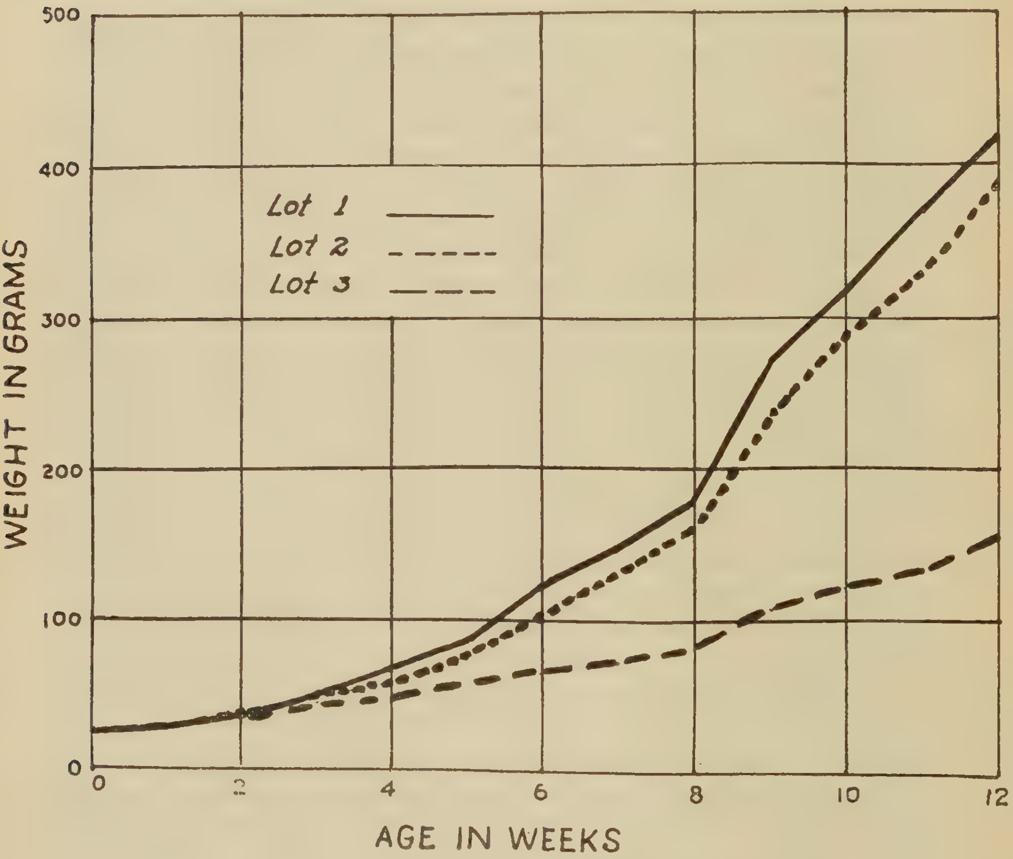

Chart 1.—Showing the rate of growth of the chicks in the different lots.

The figures given above show that the weight of the chicks in the mungo meal lot was far below the normal weight of growing chicks while the weight of the mixed-supplement lot and that of the shrimp meal lot fall to the level of normal weight. The secondary sexual characteristics of some of the chicks in the mungo meal lot were so undeveloped that at the age of 12 weeks the cockerels could hardly be distinguished from the pullets. The secondary sexual characteristics of the chicks in the mixed-supplement lot and in the shrimp meal lot were, however, fully developed at this age.

Amount of feeds consumed. Table 2 shows the amounts of feed consumed by the chicks in the different lots. These amounts were computed on the basis of 100 birds so that comparison may be made directly. To produce 100 weanlings it was observed that it required 227.7 kgm. of feed for the shrimp meal lot; 221.1 kgm. for the mixed-supplement lot and only 169.9 kgm. for the mungo meal lot. It is apparent that the chicks in the shrimp meal lot consumed a greater amount of feed to produce 100 birds to 12 weeks of age than the chicks in the mungo meal lot. The chicks in the mixed-supplement lot, however, consumed about the same feed as those of lot 1 (shrimp meal lot) to produce 100 birds to 12 weeks of age.

Computing the average daily protein and calories intake per chick per day it was found that the average daily protein intake per chick per day was 3.56 grams for lot 1, 2.94 grams for lot 2 and 1.91 grams for lot 3. The feed intake per day furnished 78, 77, and 59 calories per chick in lot 1, lot 2 and lot 3, respectively. These figures show that the chicks in lot 3 ate very little feed as compared with those in lots 1 and 2 and, consequently, their protein and the amount of calories furnished by the ingested feeds were very low. This low feed intake of the chicks in this lot may be one of the reasons the rate of their development was far below the normal level.

That the shrimp meal lot and the mixed-supplement lot consumed much larger amounts of feed than the mungo meal lot was probably due to the difference in palatability of the rations. Tuason and Fronda (1924) in their work on the availability and palatability of Philippine poultry feeds found that among the ground feeds they tested, dried shrimps (shrimp meal) was the most palatable, with ground dried fish as a close second and mungo meal third. In this experiment it was observed that the mixed-ration (shrimp meal plus mungo meal) was as much relished by the chicks as the shrimp meal ration. The ration containing mungo meal alone as protein supplement was not relished by the birds. It was observed that they did not enjoy eating the feed. The chicks showed interest in the feed when it was put in the feeding trough but a few minutes later they went out into the yard to scratch. It is interesting to note that during the first four weeks of the experiment particles of mungo were left in the feeding trough every noon, while no particle of corn was left.

Cost of production. Table 3 shows the cost of producing 100 birds raised up to 12 weeks old. It may be seen in this table that the cost of feed per 100 birds raised to 12 weeks of age in the mungo lot was ₱3.33 less than that of the shrimp meal lot. But computing the value of birds in relation to the cost of feed consumed, the same table shows that there was a return of only ₱0.26 above the cost of feeds in the mungo meal lot, and ₱12.80 in the shrimp meal lot. The mixed-supplement lot followed a close second to the shrimp meal lot in returns per 100 birds, giving ₱11.28.

Table 3 also shows that it required ₱0.12 worth of feeds to raise one bird to 12 weeks old in the shrimp meal lot, in the mixed-supplement lot, ₱0.12 and ₱0.09 in the mungo meal lot. Although it cost less to raise a chick to 12 weeks old in the mungo meal lot, the mungo meal ration used in this lot is not economical and is unprofitable to feed to growing chicks.

The results show that mungo meal used alone as protein supplement to a mash mixture consisting of corn and rice bran will not lower the cost of production. Mungo meal may, however, be mixed with shrimp meal depending on the cost and availability of mungo in a locality. The amount of mungo meal added in the mixed-supplement ration in the present study did not give any advantage in growth of the birds over shrimp meal as sole protein supplement to corn and rice bran. The best proportion in which mungo meal may be combined with shrimp meal and used as supplement in rations for growing chickens is yet to be determined.

Mortality of chicks. By reference to table 4 it may be seen that out of the 160 chicks used, in each lot at the end of the twelfth week there were only 70 chicks left in the mungo meal lot, 98 chicks in the mixed-supplement lot and 96 chicks in the shrimp meal lot. Expressing these figures in percentages, the mortality in the mungo meal lot was 56.2 per cent; 38.7 per cent in the mixed-supplement lot and 40.0 per cent in the shrimp meal lot. It may be noted that the percentage mortality of the chicks in the mungo meal lot was very much higher than the percentage mortality of either the shrimp meal or the mixed-supplement lot. It may be seen also that the percentage mortality in all the lots was rather high. This may be because the chicks were raised out of season, between April and November. The weather was very unfavorable for the chicks during this period as it rained almost every day. Some of the chicks contracted colds, catarrh and roup.

Minor observations. It was observed that in all the three sets studied the chicks in the shrimp meal lot were the most vigorous and active. The chicks in the mungo meal lot were also active during the first three weeks. Later, however, they were observed to huddle together early in the morning and late in the afternoon, especially when it was raining. The feathers of the chicks in this lot were the slowest to grow of the three lots. Many chicks, especially the males, had not grown even their flight feathers when 12 weeks old.

It was observed that at the age of from two to six weeks some of the chicks in the shrimp meal lot suffered from leg-weakness. Very few chicks were affected with leg-weakness in the mixed-supplement lot and none in the mungo meal lot. Leg-weakness was observed when the chicks were not allowed to go out of the brooder house for green feeds for a week or more. No leg-weakness, however, was observed in the mungo meal lot.

In all the lots, ocular roup affected the chicks at the age of four to six weeks. It was, however, most prevalent in the mungo meal lot. In fact this trouble was one of the main causes of the many deaths of the chicks in this lot.

SUMMARY AND CONCLUSIONS

From the results obtained in this experiment the following summary and conclusions may be presented:

1. The ration supplemented with shrimp meal produced much more vigorous chicks than the rations supplemented with either mungo meal or the combination of fifty parts of shrimp meal and fifty parts of mungo meal.

2. The chicks in the shrimp meal lot were very much larger than the chicks in the mungo meal lot. The chicks fed with a combination of shrimp meal and mungo meal were about the same in size as those of the shrimp meal lot but they were not as uniform in size as the chicks in the shrimp meal lot.

3. The chicks fed with a ration supplemented with mungo meal alone did not develop normally.

4. It was observed that the mungo meal ration failed to promote the normal sexual development of the chicks.

5. The ration supplemented with mungo meal was not palatable. The mixed and the shrimp meal supplements were very palatable.

6. It was very apparent that the mungo meal was not economical when used alone as supplement in rations for chicks. The shrimp meal ration was the most economical and the most profitable. The mixed-supplement ration was fairly profitable and economical.

7. The brooding mortality of the chicks in the mungo meal lot was very much higher than the brooding mortality of the chicks in

the shrimp meal lot. The chicks in the mixed-supplement lot had the same brooding mortality as those in the shrimp meal lot.

8. Mungo meal was observed to be inefficient in stimulating the growth of feathers of the chicks.

9. It is not advisable to use mungo meal alone as supplement to rice bran, and corn meal for chicks.

10. Mungo meal in the amount used in this study added to shrimp meal did not give any advantage in the growth of the birds over shrimp meal as source of protein supplement to corn and rice bran, neither did it reduce the cost of raising the chicks to 12 weeks of age.

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TABLE 1

Showing average weekly weights of chicks in the three lots raised to 12 weeks old

AGE	LOT 1 (SHRIMP MEAL)		LOT 2 (SHRIMP MEAL - MUNGO MEAL)		LOT 3 (MUNGO MEAL)	
	Number of birds	Av. weekly wt.	Number of birds	Av. weekly wt.	Number of birds	Av. weekly wt.
		grams		*grams*		*grams*
1 day	160	23.8	160	23.5	160	24.1
1 week	139	27.9	128	27.2	149	28.2
2 weeks	120	34.7	124	35.8	133	33.8
3 "	111	48.2	114	46.9	123	40.3
4 "	105	65.5	112	58.9	122	46.5
5 "	104	88.4	108	75.6	119	55.3
6 "	103	122.6	105	102.2	116	64.6
7 "	101	149.1	102	130.4	109	70.2
8 "	100	177.6	102	159.0	94	80.7
9 "	98	272.7	102	234.0	82	109.3
10 "	97	312.1	99	283.4	76	120.3
11 "	96	371.1	98	326.0	71	132.1
12 "	96	419.1	98	383.8	70	154.7

TABLE 2

Showing the amount of feeds consumed by the chicks in the three lots, computed per 100 birds

LOT NO.	GRAIN	MASH	TOTAL
	kgm.	*kgm.*	*kgm.*
Lot 1 (shrimp meal)	110.5	117.2	227.7
Lot 2 (shrimp meal-mungo meal)	111.2	109.9	221.1
Lot 3 (mungo meal)	84.7	85.2	169.9

TABLE 3

Showing the cost of producing 100 birds raised to 12 weeks

ITEMS	LOT 1	LOT 2	LOT 3
	pesos	*pesos*	*pesos*
Cost of feeds [a]	12.35	11.75	9.02
Value of birds [b]	25.15	23.03	9.28
Value of birds above cost of feed	12.80	11.28	0.26
Cost of feeds per bird	0.12	0.12	0.09

[a] Thirty-five eggs @ ₱0.02 were given to each lot during the first week of the experiment.

[b] The birds were valued at ₱0.60 per kgm. live weight.

TABLE 4

Showing the summary of percentages of mortality of chicks in the three lots

ITEMS	LOT 1	LOT 2	LOT 3
Number of birds at start	160	160	160
Number of birds at the end of 12 weeks	96	98	70
Percentage mortality	40	38.7	56.2

A COMPARATIVE STUDY OF TWO METHODS OF EMASCULATING RICE FLOWERS FOR ARTIFICIAL HYBRIDIZATION WORK[1]

Maxima B. Mulimbayan

WITH TWO PLATES AND ONE TEXT FIGURE

In the Philippines some thousands of rice varieties are known to exist but because most of these varieties possess undesirable characters, only a few are grown on a commercial scale. Even the outstanding rice varieties of commerce need further improvement. The combination and fixing of desirable characters by crossing or hybridization and the elimination of the undesirable ones by selection are some of the effective means of rice breeding. Rice improvement by hybridization entails some difficulties in view of the nature of the rice flower and its attendant pollination habits. The present work is concerned mainly with manipulatory processes prior to and during actual crossing work.

The rice flower being ordinarily bisexual or hermaphroditic, requires mechanical treatment to insure cross-pollination. In the Philippines, no critical account of actual cross-pollination work has been reported in detail, although several methods of emasculation are known. The present investigations were planned to test the relative efficiency of the methods involved, especially as they apply to long and short-glumed varieties of Philippine rice.

REVIEW OF LITERATURE

In the Philippines, Torres (1923, 1927) and Rodrigo (1925) emasculated the rice flower by cutting off the upper half portion of the glumes, from which the anthers were removed.

In Java, hybridization of rice was begun as early as 1907 by Van der Stok as cited by Jones (1924) and Van der Meulen (1933). The operation of emasculation was to cut off the tip of the glumes a few hours before dehiscence, then the exposed anthers were removed with a fine needle and the emasculated flowers pollinated a few hours later with the pollen of the male flowers. The panicles were protected with a gauze envelope. With this method it was reported that from zero to 43 per cent of grain setting was obtained.

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In India, Sharngapani (1924), Ramiah (1927) and Ramaswany (1933) emasculated rice flowers by carefully opening the glumes with a pair of forceps and pollinating them on the same day.

Hybridization work has been practised in Italy since 1926 by Doctor Orlandi of Bologna as cited by Dumont (1933). The method consisted in cutting out from one-fourth to one-third of the length of the glumes. The plants to be hybridized were planted in cement troughs, the male and female side by side. The plantings were so adjusted that they would flower at the same time. As soon as the panicles were out the mother flowers were emasculated and bagged, until the father plant shed pollen, which was shaken over the mother plant. Sampietro (1933) of Vercelli used the same procedure except that he castrated the female flowers in the morning of pollination. It was reported that the normal success was 30 per cent and rarely exceeded 50 per cent. The most recent report on artificial hybridization at Vercelli was included in the observations of Van der Meulen (1934).

In Japan, rice hybridization was started in 1901 by Hoshino. According to Jones (1929), Hoshino's method of emasculation consisted in clipping off the glumes of the female parent.

According to Jones (1929) crossing of rice was tried in Brigg's Rice Station in California as early as 1920-1921. The first method used was to gently pull the glumes apart and remove the anthers. The method of emasculation employed recently which gave a percentage of success of from five to twenty-five consisted of clipping off the ends of the glumes before removing the anthers.

OBJECTS OF THE STUDY

The objects of the present study were: (*a*) to make observations on the relative efficiency of two methods of emasculation of rice flowers; namely, by cutting out the tip of the palea and by mechanically opening the two glumes; and (*b*) to test which of the methods is convenient to use with rice varieties with long grains and with small grains.

TIME AND PLACE

The studies were conducted in the Plant Breeding Gardens and Laboratory of the Department of Agronomy, College of Agriculture, University of the Philippines, Los Baños, from July, 1934 to February, 1935.

MATERIALS AND METHODS

Varieties used

Upland. The two varieties used for the upland culture were Binagong Tao, a long-grained variety and Kuliit, a short-grained variety. The seeds were obtained from the Farm Crops Division of the Agronomy Department.

Lowland. Two varieties were also used for the lowland culture. As with the upland varieties, they represent the long and the short-grained varieties. The Ng Tani, an introduced variety from Siam was the long-grained type used and the Binohañgin variety secured from Bulacan Province was the short-grained type.

Methods of planting

The seeds of each variety were potted in petroleum cans. Each variety was represented by at least 100 plants. The upland varieties were planted in cans with holes in the bottom. In the upland culture nine plants were grown in each can. The lowland varieties were grown in cans without holes in the bottom so the water would be retained. For the lowland culture five plants were allowed to grow in one can.

In both upland and lowland cultures the plantings were made 10 days apart. The plantings were so dated that the periods of heading of the upland and lowland varieties would coincide and thus facilitate varietal crossing.

Methods of emasculation

Clip method. At the blooming period the rice glumes which had not opened were clipped off by cutting them from one-fourth to one-third the size of the grain and then removing the anthers. This method was used for both the long- and short-glumed varieties of both the upland and lowland cultures. The dehiscence commenced as early as 8:00 o'clock in the morning on sunny days and as late as 2:00 o'clock in the afternoon on rainy days. The greatest amount of dehiscence was observed from 10:00 o'clock in the morning to 12:30 in the afternoon. Generally, the rice panicle was emasculated a day after its appearance from the leaf sheath. In some cases a few of the rice flowers opened on the same day they appeared, especially when a portion of the panicle was out of the sheath before noon. In emasculating where the flowers were already open they were cut off and disregarded. To properly keep track of the identity of the treated spikelets, the very young ones and any flower that had not been emasculated were cut off.

Emasculation was performed in the morning, and generally about one and a half to two and a half hours before dehiscence. This time was determined by previous observations. The pollination was done on the same day the flowers were emasculated.

Split method. By this method the two glumes were mechanically forced to open either by the hand or with a pair of fine forceps, and the anthers gently removed with the forceps. The stage of the flower and time of emasculation were the same as in the clip method. Under the split method, it was observed that the flowers closed normally after the operation, provided the work was carefully done without injuring the cells, otherwise the flowers withered. The writer tried to observe whether the closing of the glumes was affected by presence or absence of fertilization, so a few spikelets were emasculated, pollinated, and bagged. After twenty-four hours they were found to be closed, indicating that the closing of the glumes was independent of fertilization.

Suction method. Under this method, the anthers exposed by clipping or splitting were sucked away by a water jet glass nozzle ending in a fine point. This method was tried by Van der Meulen (1933) in Java and found to be the most efficient method of castration. In the author's experiments the suction apparatus did not work well. The main trouble was that the holes were plugged up by the anthers that were sucked in. The time spent in removing this plug was more than that used in either of the other two methods. For this reason, only two panicles were treated by this method and then it was discontinued.

Method of recording the treated flowers

In all the different kinds of technique employed the number of flowers treated per hour was noted. This was done by recording the time each panicle was begun and the time finished. Then the total of minutes per method for each of the long- and short-grained varieties was reduced to hours and divided by the total number of flowers treated. The temperature at the time of operation was also recorded.

In both methods, each panicle treated was labeled. The first panicle of the upland culture long-grained variety treated was labelled U-L-1, and so on up to the last number of treated panicles. The same was done with the upland short-grained variety, except that the label was U-S meaning upland culture short-grained variety. In the lowland culture the same procedure was employed using L-L for the long-grained and L-S for the short-grained variety.

The emasculated grains were observed at the end of the second week. At this time, if they were to develop at all, they were discernible. The forming grains were then counted at this time and another counting was made at harvest time.

Method of pollination

The pollen grains were gathered in a watch glass at the time of dehiscence and were applied to the stigmas with a fine camel's hair brush or a pointed needle. When emasculation was done some hours before the pollen grains were available, the panicles were bagged after emasculation to prevent contamination, but when pollen was available the stigmas were pollinated just after emasculation. In all cases, artificial cross-pollination was always effected at the time of the natural anthesis of the male parent so as to insure the maximum viability of the pollen. All pollinated panicles were bagged after emasculation. For bagging materials a thin light paraffin paper bag or cellophane tobacco wrappers were used with success.

The pollination was either close or cross; just as the pollen grains were available. The close-pollination was done by taking pollen grains from the flowers of the same variety. The cross-pollination was performed by applying pollen grains from another variety. Both close and cross methods of pollination were used, because the study was mainly concerned with the merits of the two methods of emasculation, irrespective of the nature of the pollen applied.

Microscopical study of pollinated stigmas

For the purposes of microscopical study of pollinated stigmas, a few of the emasculated flowers of both long and short varieties of rice pollinated by close and cross methods were collected after pollination at intervals varying from 6 to 24 hours. The stigmas of these flowers were placed in Formo-alcohol solution in separate vials for microscopical study. The preserved stigmas were microscopically studied after having been stained according to the method outlined by Chandler (1931).

Germination of artificially pollinated grains

The grains which developed from the emasculated flowers were germinated both in artificial media and sand. The Pathology Department was consulted for the media, and it recommended the use of Crone's solution.

The grains from each panicle were hulled separately, keeping their corresponding labels, and were washed with sterile water. The water was then drained off completely and sufficient 1:1000 mercuric chloride solution to cover the kernels was poured into the tubes. The kernels were allowed to stay in the solution for 10 to 15 minutes. Then it was drained off and the kernels were washed with sterile water five times. The kernels when completely drained were transferred to the Petri dishes with a platinum loop. They were placed at a reasonable distance apart to prevent contamination whenever infection might occur.

This method of germination was found to be very laborious. For this reason, germination of the formed seeds was tried in sand medium previously sterilized by heating. The sand was placed in porcelain tumblers and moistened. To this sand, one-half of the formed grains from each panicle under either method of emasculation was placed directly in the porcelain tumblers and allowed to germinate. For comparison, the other half was germinated in agar medium.

EXPERIMENT AND RESULTS

Tables 1 and 2 present the comparative efficiency of the clip and split methods as they apply to the short- and long-grained varieties.

Table 3 presents the summary of the germination test in both Crone's solution and sand media.

DISCUSSION OF RESULTS

The relative time of blooming of the varieties

The Binagong Tao, an upland long-grained variety, flowered from October 5 to November 22, 1934; the Kuliit, an upland short-grained variety, bloomed from October 15 to November 30; the Binohañgin, a lowland, short-grained variety, flowered from October 19 to December 5; and the Ng Tani, a lowland long-grained variety, bloomed from November 10, 1934 to January 3, 1935. The varietal range of blooming periods was as early as October 5, 1934 and as late as January 3, 1935. Within this period lasting about two months, the blooming of different plants of each variety belonging to upland and lowland cultures, coincide, making it possible to cross varieties differing in length of grains and cultural habits. Thus, it was possible to cross upland and lowland of both short- and long-grained varieties. The rice plants potted in cans were grown under partial shelter to protect them from heavy rain and strong wind. Because of the partial shade the flowers opened without immediately shedding pollen. The same behavior was observed by Van der Meulen (1933) in Java.

Microscopical observations on emasculated and pollinated rice flowers

Specimens representing rice pistils from the emasculating stage up to the stage 24 hours after pollination were studied under the microscope after they had been fixed and stained.

At the emasculation stage no single pollen grain was found adhering to the plumose stigma, thus indicating that there had been no chance for self-pollination to occur. At anthesis, or at the opening stage, pollen grains were found in abundance adhering to the stigmatic ends. This behavior is in accord with the processes involved at the time of natural pollination. The stigmas which were pollinated and collected 6 hours later had several pollen grains adhering to the stigmatic surface, but not in such abundance as those found at stage of anthesis. Both the stigmas emasculated and pollinated under clip and split methods were mounted and they were found to have practically the same amount of pollen grains. The same was true with both the long- and short-grained varieties. The growth of the pollen tube was not discernible on six-hour old pollinated stigmas. The stigmas which were pollinated and collected after 24 hours were observed to have an abundance of pollen grains adhering to the stigmatic ends and with well marked pollen tube growths. In neither the long- nor short-grained varieties, emasculated under the clip and split methods, were marked differences observed in the number of pollen grains artificially applied to the stigmas. This observation shows the uniformity of skill and care exercised during the pollinating operations.

Variability of grain formed under the two methods

The grains from emasculated flowers under the split method were formed normally, although in rare cases the glumes failed to close completely. This failure of the glumes to close completely was perhaps due to the breaking off of the cells at the hinge when they were forced to open at greater angles than they normally do at time of natural anthesis. The failure, however, of the glumes to close completely did not prevent the seeds from growing normally, because the fertilized grains were observed to develop normally, even though they were partially exposed. Grains formed in partly closed glumes became susceptible to fungus and insect attacks. On the other hand, under the clip method of emasculation the grains formed were quite abnormal in size because the upper portion was exposed. The tip of the seeds tends to grow longer and more tapering in shape and sometimes a little more slender than normally formed grains. The portion which remained covered was normal (pl. I and II).

Difficulties encountered in applying the different methods to long- and short-grained varieties

The clip and split methods of emasculation were found not to be equally suitable for the long- and short-grained varieties of rice. In the long-grained varieties, the clip method seemed to be well adapted to the work because the grains were large enough to handle, the point of the forceps could be easily inserted through the clipped portion, and anthers could be taken out without much difficulty. Because of the size of grains, the split method also was found to be equally convenient. In the short-grained varieties the glumes were so small that it was rather difficult to pull out the anthers through the cut portion. Under the split method, the greatest handicap was due to the small size of grains, thus the mechanical force in opening the glumes was difficult to control, consequently the palea were forced to open too wide. This forced opening sometimes resulted in the falling off of the treated florets.

Comparative efficiency of the clip and the split methods

The summary of results of the emasculation under the clip and split methods may be found in tables 1 and 2. It may be noted in table 1 that the number of grains emasculated per hour of close pollination was 61.32 in the long varieties; 56.06 grains in the short varieties; 59.93 grains per hour of cross-pollinated grains in the long varieties and 56.82 grains per hour in the short varieties. The percentage of seeds formed that reached maturity in the close-pollinated grains was 25.42 in the Binagong Tao and 34.13 in Ng Tani. The close-pollinated grains of the short-grained variety gave 23.29 per cent of seeds formed in Kuliit and 35.58 per cent in Binohañgin. The cross-pollinated grains of the long varieties gave 31.41 per cent in Binagong Tao and 38.07 per cent in the Ng Tani. The short varieties gave 24.31 per cent in Kuliit and 30.25 per cent in the Binohañgin.

In table 2, it may be noted that the grains emasculated per hour in the long varieties close-pollinated grains averaged 55.07 grains per hour, and in the cross-pollinated ones, 55.76 grains. The short varieties gave an average of 51.58 grains per hour in the close-pollinated grains and 51.96 grains in the cross-pollinated ones. In the long-grained variety, the percentage of grains formed that reached maturity was 29.28 in the Binagong Tao and 29.88 in the Ng Tani. The close-pollinated grains of the short-grained varieties gave 23.05 per cent of seeds formed that reached maturity in Kuliit and 32.39 per cent in Binohañgin. The Binagong Tao gave 31.69 per cent of the cross-pollinated grains and the Ng Tani, 32.94 per cent. The Kuliit variety gave 31.31 per cent of the cross-pollinated grains and the Binohañgin gave 23.11 per cent.

The foregoing results indicate that under both the clip and split methods of emasculation more time was consumed with the short-grained varieties. Clipping long-grained varieties gave an average of 60.63 grains per hour, while for the short-grained varieties the rate was 56.44 grains per hour. The splitting procedure gave about 55.42 grains per hour for short-grained. It may be argued that because of handling small flowers, a greater number could be handled per unit of time, but the present experiments point the reverse. It was experienced that all small-grained varieties take a longer time to handle than the long-grained ones.

It may be of interest to compare the present results on rice emasculation by clipping with those obtained elsewhere, especially in Java. The cutting off the glumes one-fourth to one-third the size and the pulling off of the anthers was considered the old method of emasculation in rice. According to Van der Meulen (1933) this emasculation by clipping gave a rate of 25-50 flowers per 5-hour operation or a rate of 5-10 flowers per hour. An improvement introduced by him by sucking away the anthers instead of pulling them out yielded 100-150 flowers per 5-hour operation or a rate of 20-30 flowers per hour. This rate of 20-30 flowers per hour was considered the result of the most efficient method of emasculation. The method used in the present work gave an average rate of 56 to 60 flowers per hour.

Germination tests

The results on germination tests of grains are summarized in table 3.

It may be seen in this table that the seeds in the Crone's solution gave a relatively higher percentage of germination than those germinated in the sand medium. The close-pollinated grains gave higher percentages of germination than the cross-pollinated grains. Yoshino (1933) reports having found similar results and believes that the low percentages of germination of seeds resulting from crosses are perhaps due to the incompatibility of the two varieties crossed.

The germination, in general, was with one exception better under the split method than the clip method; the exception was Binagong Tao, where the clipped grains were a little the better. That the seeds formed under the split method had the better germination may be explained by the difference of the seeds formed under both methods. The seeds formed under the clip method were a little abnormal in size as they did not germinate normally owing to physiological disturbance during maturity.

The lower percentage of germination in the sand medium can probably be tolerated in cases where hundreds of hybrid seeds are produced and only a few of these will be used and where necessary materials for Crone's solution are not available. The high percentage of germination in Crone's solution compensates for the laborious task of removing the hull, washing and disinfecting the grains. A sample of germination tests under the different media is shown in figure 1.

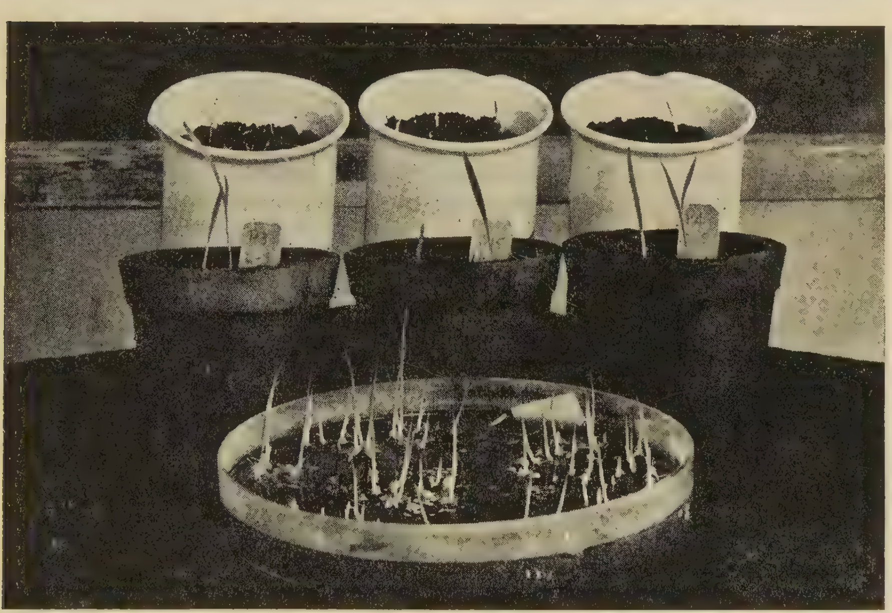

Fig. 1.—Showing the germination tests of artificially pollinated grains. Porcelain tumblers contain sterilized sand with sprouted grains. Earthen pots in which seedlings were transferred. Petri dish contains Crone's agar medium and germinating seedlings.

The artificially pollinated grains resulting from close- and cross-fertilization were found to germinate even when they had not fully matured. This was observed when the plants were partly damaged in each of three typhoons. Even grains with a green hull but hard endosperm germinated like normally ripened grains.

The germination in the sand medium gave lower percentages, but the relative percentages follow in general those observed under the Crone's solution treatment, in both the clip and the split methods, and with the close- and cross-pollinated grains. The lower percentage of germination was probably due to the heavy sand, and non-availability of food nutrients, because most of the seedlings died when not transferred a day or two after germination.

In all the cases the control had very much higher percentages of germination than the cross-pollinated grains emasculated under either the clip or the split methods. On the other hand, the percentages of the control were only a little higher or the same as the germination of the close-pollinated grains. It would seem that those grains which were close-pollinated are highly compatible, since they are of the same variety.

Advantages and disadvantages of mechanically treating rice flowers

Clip method. The advantages of this method of emasculation are, that it is simple as it requires the cutting off of only the top portion, it is quicker to operate than the split method, pollination is easier because the partially cut glumes catch the pollen grains introduced and hold them well.

The disadvantages of this method are that the fertilized seeds are partly exposed, thus hindering their development and rendering them susceptible to insect and fungus attacks, and the fertilized grains showed poorer germination, generally, than with the split method. This low germination was probably due to the abnormally developed grains which resulted under this method.

Split method. The advantages of the split method of emasculation are, that the fertilized seeds are normally developed, because the glumes in most of the cases are closed just as the normal grains are, and the germination in general was better than under the clip method.

The disadvantages of this method are that it requires the careful splitting of the glumes before the anthers could be removed, because of this it requires a longer time than the clip method.

The time required to emasculate the long and short varieties differs under the two methods of emasculation (see tables 1 and 2). It was found that under the clip method with the long varieties the average number of grains emasculated was 60.63 per hour. Under the split method the average number of grains emasculated per hour was 55.42. That 4.94 more grains per hour were emasculated by the clip method was due to the ease of operation. In the short varieties, under this method an average of 56.44 grains per hour were emasculated, and by the split method 51.77, which is 4.67 less than by the clip method.

In both the long and the short varieties, it is evident that operation by the clip method is faster than by the split method. It was observed also in each of the methods that because of the ease of handling the long grains the time consumed with them was less than that with the short grains.

For purposes of biological soundness, it may be pointed out that in clipped glumes the fine forceps are inserted through the open tube of the floret, and stamens are pulled out by crushing or pressing the anthers. In this way the pollen sacs are likely to burst, thereby contaminating their own stigmas and the fertilization resulting may or may not be the result of cross-pollination. However, if precautions are taken not to break the anther sacs, the likelihood of self-fertilization can be overcome, as was found in the microscopical observations on emasculated and pollinated rice flowers. Under the split method of emasculation this danger of contamination seems to be remote for the stamens are generally removed by handling the filaments.

SUMMARY AND CONCLUSIONS

In these experiments, comparative studies were made to determine which of two methods of emasculating rice flowers, the clip method or the split method, is the more efficient and which of the methods can be applied the most conveniently to long- and short-grained varieties of rice. The clip method of emasculating rice consists of cutting the rice glumes one-fourth to one-third the size and of removing the anthers with a pair of forceps. The split method consists of mechanically forcing, either by the hand or with a pair of fine forceps, the two glumes to open and by removing gently the anthers. The experimental results may be summarized as follows:

1. Under the clip method of emasculation the average percentage of success on the basis of treated grains that reached maturity was 32.69 in long-grained varieties and 29.61 in short-grained varieties. Under the split method the average percentage of success was 30.78 in the long-grained varieties and 25.56 in the short-grained ones.

2. The average number of grains emasculated per hour under the clip method was 60.63 in the long-grained varieties and 56.44 grains in the short-grained varieties. It may thus be seen that the clip method applied to both long- and short-grained varieties was not only more successful than the split method of emasculation, but required less time to perform.

3. The percentage of germination was always higher in Crone's medium than in the sand. Moreover, the germination of the close-pollinated grains was generally higher than that of the cross-pollinated ones.

4. Where a higher percentage of formed seeds is the aim, the clip method is recommended for castrating flowers, whereas if the main objective is to get a higher percentage of germination, the split method of emasculation is preferable.

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TABLE 1

Showing summary of results obtained under the clip method of emasculation

VARIETY		NATURE OF POLLINATION	TREATED FLOWERS	TIME CONSUMED	SEEDS FORMED		SEEDS MATURED	
			number	*min.*	*number*	*per cent*	*number*	*per cent*
Long-grained	Binagong Tao ..	Close	472	498	197	41.74	120	25.42
	Ng Tani	Close	838	784	398	47.49	286	34.13
	Average		61.32 grains per hr.	.98 min. to a grain				
Short-grained	Kuliit	Close	541	586	191	35.30	126	23.29
	Binohañgin	Close	814	864	384	47.17	288	35.38
	Average		56.06 grains per hr.	1.07 min. to a grain				
Long-grained	Binagong Tao ..	Cross	417	442	192	46.04	131	31.41
	Ng Tani	Cross	373	349	181	48.53	142	38.07
	Average		59.93 grains per hr.	1.00 min. to a grain				
Short-grained	Kuliit	Cross	872	921	345	39.56	212	24.31
	Binohañgin	Cross	519	548	206	39.69	157	30.25
	Average		56.82 grains per hr.	1.06 min. to a grain				

TABLE 2

Showing summary of results obtained under the split method of emasculation

VARIETY		NATURE OF POLLINATION	TREATED FLOWERS	TIME CONSUMED	SEEDS FORMED		SEEDS MATURED	
			number	*min.*	*number*	*per cent*	*number*	*per cent*
Long-grained	Binagong Tao ..	Close	649	754	197	30.35	190	29.28
	Ng Tani	Close	604	611	219	35.67	180	29.88
	Average		55.07 grains per hr.	1.09 min. to a grain				
Short-grained	Kuliit	Close	885	1054	254	28.70	204	23.05
	Binohañgin	Close	568	636	196	34.15	184	32.39
	Average		51.58 grains per hr.	1.15 min. to a grain				
Long-grained	Binagong Tao ..	Cross	284	322	91	32.04	90	31.69
	Ng Tani	Cross	504	526	191	36.80	166	32.94
	Average		55.76 grains per hr.	1.08 min. to a grain				
Short-grained	Kuliit	Cross	198	227	63	31.82	62	31.31
	Binohañgin	Cross	649	751	171	26.35	150	23.11
	Average		51.96 grains per hr.	1.15 min. to a grain				

TABLE 3

Showing the summary of results on germination tests

VARIETY		NATURE OF POLLINATION	METHOD OF EMASCULATION	CRONE'S SOLUTION			SAND		
				Seeds	Germinated seeds		Seeds	Germinated seeds	
				number	*number*	*per cent*	*number*	*number*	*per cent*
Long-grained	Binagong Tao	Close	Clip	100	63	63.00	20	9	45.00
			Split	138	81	58.69	49	25	51.02
		Cross	Clip	77	35	45.45	54	21	38.89
			Split	53	20	37.73	27	6	22.22
		Control		100	78	78.00	100	73	73.00
	Ng Tani	Close	Clip	144	73	50.69	139	53	38.12
			Split	92	61	66.30	43	88	48.86
		Cross	Clip	70	28	40.00	66	17	25.75
			Split	88	41	46.59	72	24	33.33
		Control		100	75	75.00	100	72	72.00
Short-grained	Kuliit	Close	Clip	68	49	72.06	55	36	65.45
			Split	121	91	78.21	80	57	71.25
		Cross	Clip	141	50	35.46	71	14	19.72
			Split	32	15	46.87	30	8	26.67
		Control		100	76	76.00	100	72	72.00
	Binohañgin	Close	Clip	146	94	64.38	39	78	56.11
			Split	78	65	83.33	64	46	71.87
		Cross	Clip	91	37	40.66	66	24	36.36
			Split	111	50	45.05	83	31	37.35
		Control		100	84	84.00	100	62	62.00

EXPLANATION OF PLATES

Plate I.—Showing developed panicles, emasculated under split method (1) and (2) and under clip method (3) and (4).

Plate II.—Showing the floral stages before and after emasculation: (1) and (5) the whole unopened flowers of long- and short-grained varieties, (2) and (6) flowers opened with anthers exposed, (3) and (7) developed grains under clip method, (4) and (8) developed grains under split method.

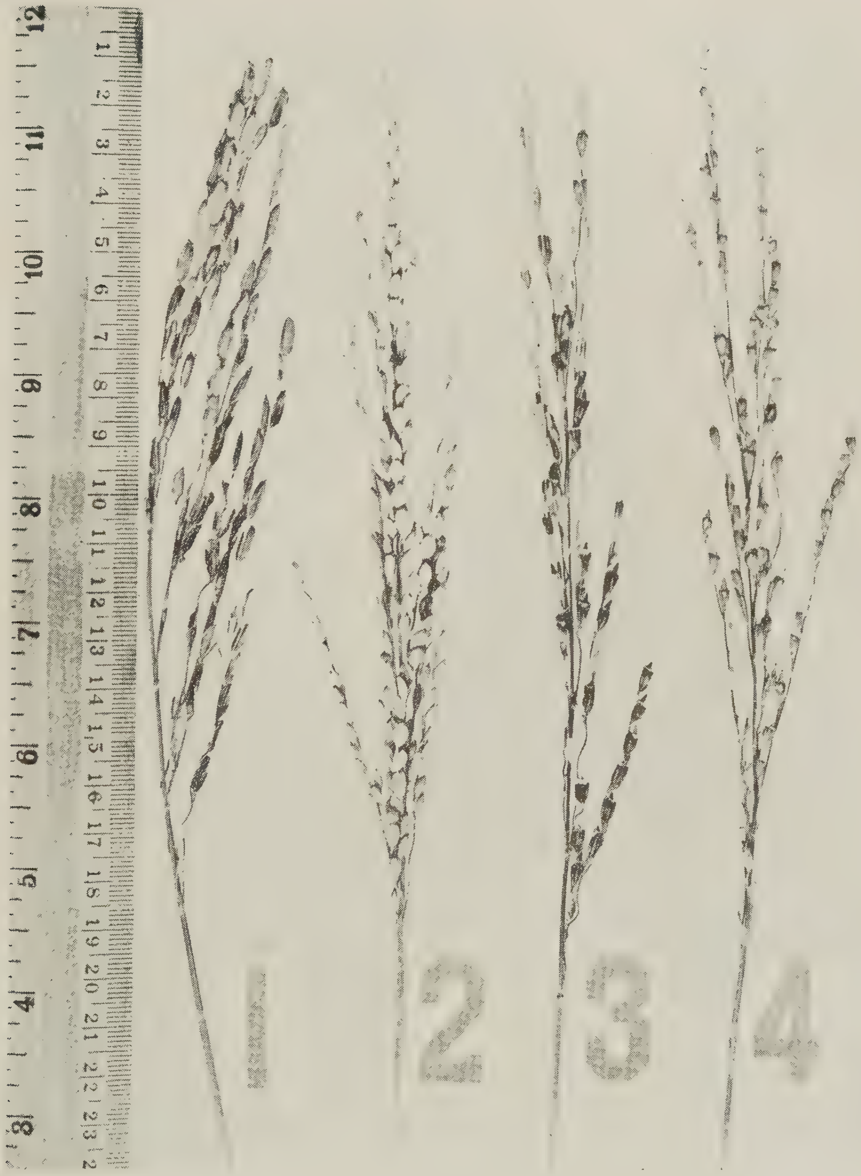

PLATE I

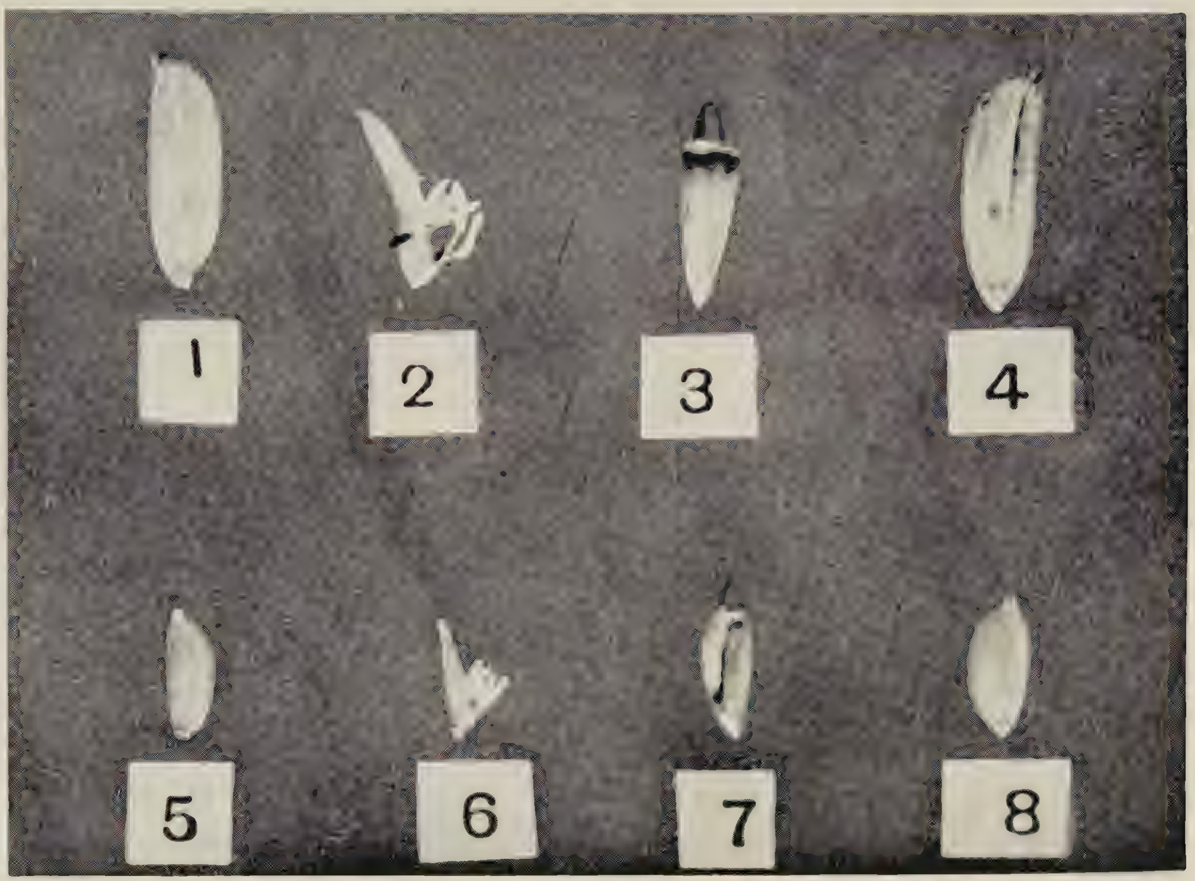

PLATE II

A STUDY ON THE CONSUMPTION OF SALT BY RANGE CATTLE[1]

LUIS A. ALDEA

WITH ONE CHART

INTRODUCTION

All kinds of live stock need mineral substances for skeletal development and for carrying out various vital activities in the animal body. Among the minerals that animals require is common salt.

That common salt is important in maintaining the health of animals was shown in an experiment conducted by Babcock and Carlyle with dairy cows (*cited by* Henry and Morrison, 1916). These cows were well-nourished except that no common salt was given for long periods. The following conclusions were reached: In every case the cows exhibited an abnormal appetite for salt after having been deprived of it for 2 or 3 weeks, but in no case did the health of the animal, as shown by the general appearance, the live weight, or the yield of milk, appear to be affected until a much longer time had elapsed. This period of immunity varied with individual cows from less than a month to more than a year. A condition of low vitality was finally reached in which a sudden and complete breakdown occurred. This stage was marked by loss of appetite, generally haggard appearance, lusterless eyes, a rough coat, and a very rapid decline in both live weight and yield of milk.

Gouin (1919) cited by Buencamino and Sales (1932) observed that animals became sterile if deprived of salt and that the ingestion of this material improved fecundity and increased milk production.

According to Hart, Steenbock, and Morrison (1923), dairy cows should receive at least one ounce (28.35 grams) of salt per head daily. The salt may be mixed with concentrates at a ratio of from one-half pound (226.78 grams) to one pound (453.59 grams) salt to 100 pounds (45.5 kgm.) concentrates. The animals should in addition be allowed free access to salt, so they may get what they want. These authors state that farm animals need common salt in the ration because the crops and feeds fed to them are very low in chlorine, the element furnished by common salt.

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[1] Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 475; Experiment Station contribution No. 1075. Prepared in the Department of Animal Husbandry under the direction of Dr. Valente Villegas.

Sotola, Smith, Ellington and Cassel (1924) point out that Kellner recommends ¾ to ½ ounces (21.24 to 42.51 grams) of salt daily for cows. A high-producing cow may be given as much as 3 ounces (85.02 grams) of salt daily. They also reported the work conducted in Kansas Experiment Station (1921-22) on cattle salting studies in dry lot. From this investigation it was found that the average salt consumption per steer over a period of 150 days was 15.59 pounds (7.1 kgm.) of salt in the case of steers fed alfalfa hay as roughage and 46.63 pounds (21.2 kgm.) with steers fed silage. These figures show that the nature of the ration fed affects the amount of salt eaten by the animals. Steers on the range consumed 2.42 pounds (1.1 kgm.) of salt per head each month during the early grazing season, an equal quantity of salt being wasted because of weathering. Toward the end of the season the consumption was less, only about 1.77 pounds (0.8 kgm.) per steer each month, an equal amount being lost through weathering.

Maynard (1925) states that the palatability of salt may be increased by including it in mineral mixtures, as follows:

Mixture No. 1	200 pounds	(90.9 kgm.)	bone meal.
	100 pounds	(45.5 kgm.)	salt.
Mixture No. 2	100 pounds	(45.5 kgm.)	bone meal.
	100 pounds	(45.5 kgm.)	finely ground limestone.
	100 pounds	(45.5 kgm.)	salt.

Such mixtures may be given to animals at all times.

Chapline and Talbot (1926) reported that cattle need about 2 to 2½ pounds (0.9 to 1.4 kgm.) of salt per head monthly on the range when the feed is succulent or when browsing plants form the bulk of the ration. During the rest of the season 1 to 1½ pounds (0.5 to 0.7 kgm.) per head a month is usually adequate. An amount of 20 pounds (9.1 kgm.) per head yearly is considered a fair salt allowance on the range.

According to Roberts (1929), A certain amount of salt is necessary for the health of all animals, it being an essential constituent of saliva, gastric and other juices, and also the source of free hydrochloric acid in the gastric juice. It also helps digestion by assisting in the passage of certain substances through the walls of the stomach and intestines, and it is also necessary for dissolving the proteins. Salt is also a necessary constituent of blood, lymph, etc. A cow provided with an insufficient amount of salt over a long period has been described as developing a strong craving for it, gradually losing vitality, becoming rough-haired, thin in flesh and finally suffering a complete breakdown.

The objects of the present study were: (*a*) to determine the amount of salt consumed by range cattle; and (*b*) to ascertain the amount of water absorbed by salt when exposed to open air so that losses through leaching may be lessened.

This work was conducted in the Department of Animal Husbandry, College of Agriculture, University of the Philippines. It was begun on August 30, 1931 and closed on January 31, 1933, covering a period of 17 months.

ANIMALS

The animals used in this investigation consisted of range cattle belonging to the College of Agriculture. They were grouped together in three herds known as the Nellore, Hereford and Grade herds. As may be seen in table 4, the Nellore herd consisted of ten purebred Nellore cattle. There was one male in the herd and nine females. They ranged in age from 10 months to 6 years at the beginning of the experiment. Table 2 shows the animals in the Hereford herd. There were nine animals in the herd, four of which were purebred Herefords and 5 grades possessing one-half or more of Hereford blood. One was a male and eight were females. Their ages varied from 10 months to 13 years when the work was begun. As may be seen in table 3 there were twenty-six animals in the Grade herd of which twenty-five were females and one was male. The animals were of different blood composition. Sixteen of them had one-half or more of Hereford blood, eight, one-half or more of Nellore blood and two, one-half Holstein blood. Their ages ranged from 3 months to 11 years at the beginning of the work.

PASTURES

Pasture for the Nellore herd. This pasture is generally rolling. A creek flowing through it divides it in two equal parts. In the lower portion there are about two hectares that are fairly level. Certain parts of the land are too steep for easy grazing, but about 80 per cent of it is of moderate topography. The approximate area of the whole pasture is 14 hectares. The elevation varies from 12 to 30 meters above the sea level (Barsana, 1927). About 80 per cent of the pasturage is cogon, *Imperata cylindrica* (Linn.) Beauv. var. *koenigii* (Retz.) Benth.; the slopes are covered with culape, *Paspalum conjugatum* Berg.

Pasture for the Hereford herd. Adjoining this pasture on the western side the land is rolling. The total area is about 6.6 hectares. The greater portion of the pasture is covered with ipilipil, *Leucaena glauca* (Linn.) Benth. the leaves of which were eaten by the cattle. Other edible forages found in the pasture are culut-culutan, *Urena lobata* Linn. and culape. The elevation of the hilly portion of this land varies from 12 to 30 meters above the sea level (Barsana, 1927).

Water was made available for the animals in a tank connected with a pipe to the water supply of the College of Agriculture.

Pasture for the Grade herd. Most of this pasture is level, a small portion of it slopes abruptly towards an adjoining field. The elevation varies from 12 to 30 meters above the sea level (Barsana, 1927). Most of the lower portion is covered with cogon. Culape grows along the creek. Water is available in the creek which flows along one side of the pasture.

SHEDS AND SALTING BOXES

Before beginning this work, sheds of mixed materials were built. The posts were made of concrete, the roof was of galvanized iron and the rest of the shed of lumber. The length of the shed was 8 meters and the width 5 meters. The lower edge of the roof was 2 meters from the ground.

Each shed was provided with at least one wooden salting trough, 3 meters long, 1 meter wide and 30 centimeters deep. The bottom of the trough was 45 centimeters above the ground. A partition ran through the trough lengthwise, so more animals could lick salt at the same time. The trough was placed in the middle of the shed to prevent the rain from wetting the salt. The troughs were so made and were so heavy that the animals could not turn them over or move them.

SALT

The salt used in this experiment was sea salt obtained in Parañaque, Rizal. It was manufactured by the *iras Tagalog* method (Cox and Dar Juan, 1915). The weight of one sack of this salt was about 43 kgm. The average price per kgm. throughout the year when this experiment was conducted was 1-1/5 centavos.

The salt used was analyzed in the Department of Agricultural Chemistry of the College, the amount of sodium chloride present in it being 80.78 per cent, and moisture, 12.45 per cent. Cox and Dar Juan (1915) give the amount of calcium oxide and magnesium oxide in salt made in Parañaque, Rizal by the Filipino method as 0.96 per cent and 0.85 per cent, respectively. A complete analysis of salt from the same place is given below.[2]

Sodium and potassium chlorides	91.17%
Calcium sulphate ($CaSO_4$)	1.55%
Magnesium sulphate ($MgSO_4$)	3.90%
Magnesium chloride ($MgCl_2$)	2.76%
Phosphorus (P)	trace
Iron and aluminum oxides (R_2O_3)	0.003%
Insoluble residue	0.61%

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[2] Analysis furnished by the Director, Bureau of Science in a letter dated February 24, 1933.

METHOD FOLLOWED

Management of animals

The animals were allowed to graze freely in their respective pastures day and night, that is, they were treated as range cattle. They had access to water at all times and the salt was supplied to them *ad libitum.* The animals were ordinarily found licking salt in the afternoon. To find out whether or not the animals were getting enough feed from the pasture the condition of the range supply and the monthly weights of the animals were observed. Throughout the experiment it was found that vegetation in the pastures was more than enough for the animals; likewise the weights of cattle in each herd showed normal increase. The fat condition of the animals was very evident.

Salting

Before starting on the actual experiment, the animals were subjected to preliminary salting trials for a period of 20 days. During the early part of the trials rice bran and molasses were mixed with the salt to induce the animals to come to the shed. It was noticed that the mixture was all consumed at each feeding time. Later on, salt alone was placed in the troughs. The animals were found to lick it regularly.

After the preliminary period a definite quantity of salt was placed in the trough about every other day. Care was taken that there was always some salt remaining in the trough at visiting time each day. In this way the animals were provided with salt at all times. At the same time care was exercised to place just about enough salt in the troughs every other day so that the loss of salt through leaching, especially during rainy months could be lessened to a great extent. With those precautions, the loss of salt, if there was any, can be considered as neglible. On the seventh day each week the left-over was weighed to determine the consumption for that week. To be able to carry out the work accurately, it was necessary to set a day for weighing the left-over in each herd. For the Nellore herd the week-end was set on Tuesday; for the Herefords, Saturday; and for the Grade herd, Thursday.

Computation of salt consumption by mature cattle

In determining the salt consumption by each animal, first the weights of all mature animals five years of age or over were added and averaged. The total of the weights of all animals younger than five years was found and the sum was divided by the average weight of the mature cattle. The weights at the beginning of each four weeks were used for each period. Young calves that were too small to reach the trough to lick salt were not included in the computation. The number of animals five years old or older plus the number representing the mature equivalent of young animals, according to weight, gave the equivalent number of mature animals. The total amount of salt consumed during the 4-week period divided by the equivalent number of mature animals in each herd, represented the average consumption of salt for each mature animal.

Determination of moisture absorbed by salt exposed to air

Samples of salt in sacks, kept in the storeroom, were submitted to the Department of Agricultural Chemistry of the College on the first day of each month for moisture analysis. From the same sacks one-kilogram samples of salt were taken and placed in a dry, clean kerosene can which was immediately hung on the beam at the middle of the shed in the Hereford herd. As the salt rusted the cans it was necessary to renew them once in two months. At the end of each month the content of the can was submitted for analysis by which the total moisture content was determined. The moisture content in the sample minus that present in the sample analyzed on the first day of the month represented the percentage moisture absorbed by the salt exposed to the air in the pasture. The amount of moisture absorbed by the salt each month upon exposure to the air determines the time of the year when salt may be placed in the troughs in greater or lesser quantities; thus, losses from leaching may be controlled.

DISCUSSION OF RESULTS

Salt consumption by the Nellore herd

As may be seen in table 4, the Nellore herd received salt from December 1, 1931 to January 31, 1933, covering a period of one year, one month, or 395 days. The equivalent number of mature animals during the 4-week periods varied from 3.5 to 8.7, the average being 7.6. The total salt consumption during the whole period was 77.3 kgm. During each 4-week period the salt consumption ranged from 2.0 to 8.8 kgm., the average being 5.2 kgm. The average amount of salt consumed per animal each 4-week period was from 0.28 to 1.66 kgm. Averaging the consumption for the whole experiment, it was found to be per mature animal 0.70 kgm. during a period of 4 weeks. At the rate of ₱0.012 per kgm. of salt, one mature animal consumed ₱0.008 worth of salt in 4 weeks, or ₱0.11 worth in one year.

When the troughs were visited in the afternoon sometimes the animals were found in the shed licking salt. Upon being approached they went out. In the open pasture a stranger could not come close to them.

Salt consumption by the Hereford herd

Table 5 shows the consumption of salt by the Hereford herd. Animals in this herd were given salt from November 28, 1931 to January 21, 1933, a period covering 418 days. The equivalent number of mature animals in the herd based on weight, during the 4-week periods, ranged from 7.5 to 9.8, the average being 8.5. The total consumption of salt throughout the whole period was 97.8 kgm. For each 4-week period the average consumption of salt was 6.5 kgm., the range being from 2.6 to 13.8 kgm. The average per mature animal for each 4-week period was 0.78 kgm. of salt; the minimum consumption was 0.30 kgm. and the maximum, 1.84 kgm. per head. The cost of salting one mature animal for a 4-week period was found to be ₱0.009; for one year the cost was ₱0.12.

On the whole, these animals were docile. When found licking the salt in the troughs, as the new supply was placed for them, they stayed in the shed and showed indifference towards men, except the two spayed heifers which were rather wild and ran away when approached. These heifers were young and very fat.

Salt consumption by the Grade herd

By reference to table 6, it may be seen that in the Grade herd the experiment covered a period of 390 days. It began January 1, 1932 and ended on January 26, 1933. This herd had the largest number of animals. The average equivalent number of mature animals for each 4-week period was 15, the range being from 13.6 to 17.7. Altogether, 187.1 kgm. of salt were consumed throughout the whole period. The minimum amount of salt consumed in a 4-week period was 9.5 kgm., the maximum, 18.3 kgm., the average, 13.4 kgm. The amount of salt consumed by a mature animal in four weeks varied from 0.68 to 1.34 kgm.; the average was 0.89 kgm. Basing computation on consumption per head per 4-week period, the cost of salt given to a mature animal for this period was ₱0.011, making the yearly cost ₱0.14.

These animals were observed to visit the salting troughs oftener than either the Nellores or the Herefords. They were so friendly that a number of them would meet the writer at the troughs when a fresh supply of salt was brought to the shed.

Average consumption of salt by the three herds

The average amount of salt consumed by cattle in the three herds in a 4-week period was 0.79 kgm. per head. On the yearly basis this consumption was about 10 kgm. of salt per mature animal, the range being from 9 to 11 kgm. Under the prevailing prices the average cost of salting each animal was ₱0.009 for a 4-week period, or ₱0.12 per head a year. The average salt consumption obtained in this work approaches that reported by Chapline and Talbot (1926) which ranged from 2 to 2-1/2 lb. (0.9 to 1.4 kgm.) per head monthly, and from 1 to 1-1/2 lb. (0.5 to 0.7 kgm.) at the end of the season, equivalent to from 7 to 14 kgm. per animal per year. Hart, Steenbock and Morrison (1923) state that dairy cows should receive 1 ounce (28.35 grams) of salt per head daily, which is equivalent to about 10 kgm. a year. Sotola, Smith, Ellington and Cassel (1924) found that the monthly salt consumption of steers on the range was 2.42 lb. (1.1 kgm.) per head or about 12 kgm. a year. These authors cite Kellner who recommends that a cow should be given 3/4 to 1-1/2 ounces (21.24 to 42.51 grams) a day, and a high-producing milch cow as much as 3 ounces (85.02 grams) daily, averaging from 11 to 30 kgm. per year. Buencamino and Sales (1932) suggest that range cattle in the Philippines be given from 6 to 12 kgm. of salt per head a year.

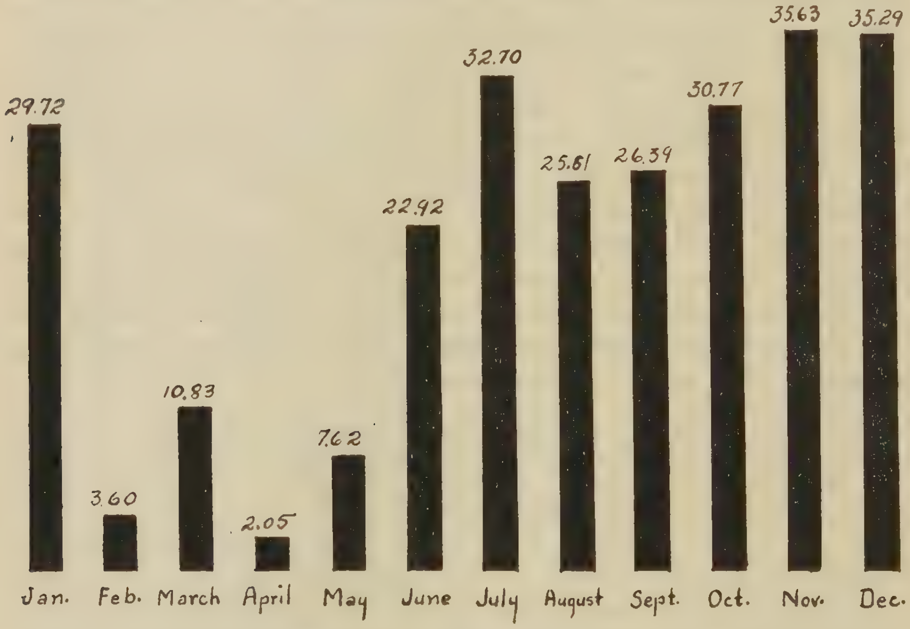

Chart 1.—Diagram showing relative percentage of moisture absorbed by salt exposed to air during different months of the year.

On the basis of the results obtained in this study it would appear that the amounts of salt consumed by range cattle in the College of Agriculture are not much different from those recommended by other workers for animals on the range.

Percentage moisture absorbed by salt when exposed to open air

As may be seen in table 7 and chart 1, the percentage moisture content of salt taken from the storeroom every month throughout the year was quite uniform, whereas the sample exposed to the air showed great variation in moisture content. This variation is due to the deliquescent nature of salt by which the amount of moisture absorbed varies according to the relative humidity of the atmosphere, which varies in different parts of the year. A large amount of moisture was absorbed by salt during January and from June till December, the range being from 22.92 per cent in June to 35.63 per cent in November. From February till May inclusive, the percentage of moisture absorbed was 2.05 per cent in April and the highest was 10.83 per cent in March.

It is, therefore, apparent that salt should be supplied to animals in small quantities from June till January when the amount of moisture in the air is quite high so that the loss through leaching can be lessened to the minimum. From February to May larger amounts of salt may be placed in the troughs for in this period the loss of salt through leaching will be almost negligible, as in these months the moisture in the air is quite low.

SUMMARY

1. The consumption of salt by range cattle was determined for a period of a little over one year, using Nellore, Hereford and Grade cattle.

2. The amount of moisture absorbed by salt when exposed to the air was also ascertained.

3. On the basis of weight, Nellore cattle were found to consume an average of 0.70 kgm. of salt per head in a period of four weeks, or an average of 9.1 kgm. a year. The range in consumption was from 0.28 to 1.66 kgm. per head each 4-week period.

4. Cattle of the Hereford herd consisting of four purebred Herefords, four animals with 3/4 Hereford blood and one individual with 1/2 Hereford blood, consumed an average of 0.78 kgm. per head each 4-week period, or an average of 10.1 kgm. a year. The consumption varied from 0.30 to 1.84 kgm. per head each 4-week period.

5. Animals in the Grade herd consumed an average of 0.89 kgm. of salt per head per 4-week period, or an average of 11.6 kgm. a year. The consumption varied from 0.68 to 1.34 kgm. per head each 4-week period.

6. An average of 0.79 kgm. of salt per head in four-weeks time was consumed by cattle in the three herds, making the yearly salt consumption by each animal 10.3 kgm. The average cost of salting an animal was ₱0.009 for a 4-week period, or a yearly cost of ₱0.12. At this rate, the cost of salting a herd of 100 mature cows for one year would be ₱12.00.

7. Loss from leaching when animals are supplied with too much salt at a time may occur from June to January when the amount of moisture absorbed by the salt varies from 22.92 to 35.63 per cent. From February to May salt remains in a relatively dry condition.

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TABLE 1

Showing the sex and date of birth of animals in the Nellore herd

HERD NO.	SEX	DATE CALVED
35	Female	February 1, 1925
42	Female	January 18, 1928
44	Female	August 2, 1928
46	Male	January 15, 1929
48	Female	January 24, 1929
49	Female	January 26, 1929
52	Female	October 25, 1929
54	Female	October 25, 1930
55	Female	December 15, 1930
56	Female	January 7, 1931

TABLE 2

Showing the sex, breeding and date of birth of animals in the Hereford herd

HERD NO.	SEX	BREEDING	DATE CALVED
4	Female	Hereford	October 12, 1918
13	Female	Hereford	February 19, 1925
14	Female	Hereford	June 3, 1925
17	Female	Hereford	April 18, 1927
148	Male	3/4 H-1/8 N-1/8 n[a]	August 13, 1928
170	Female	1/2 H-1/2 N	November 5, 1929
197	Female	3/4 H-1/4 N	October 30, 1930
199	Female	3/4 H-1/4 N	November 30, 1930
202	Female	3/4 H-1/4 N	January 28, 1931

[a] H, Hereford; N, Nellore; n, native.

TABLE 3

Showing the sex, breeding and date of birth of animals in the Grade herd

HERD NO.	SEX	BREEDING [a]	DATE CALVED
57	Female	1/2 N-1/2 n	April 22, 1920
58	”	1/2 N-1/2 n	July 4, 1920
62	”	1/2 H-1/4 N-1/4 n	April 3, 1922
78	”	1/2 H-1/4 N-1/4 n	August 9, 1923
88	”	1/2 H-1/4 N-1/4 n	April 4, 1924
96	”	1/2 H-1/4 N-1/4 n	October 26, 1924
110	”	1/2 H-1/4 N-1/4 n	December 15, 1925
121	”	1/2 H-1/4 N-1/4 n	November 17, 1926
128	”	3/4 H-1/8 N-1/8 n	May 4, 1927
130	”	1/2 H-1/2 N	June 21, 1927
141	”	3/4 H-1/4 n	February 22, 1928
142	”	1/2 N-1/4 H-1/4 n	March 20, 1928
151	”	3/4 H-1/4 N	November 23, 1928
156	”	7/8 N-1/8 n	January 31, 1929
182	”	1/2 H-3/8 N-1/8 n	March 26, 1930
185	”	1/2 H-3/8 N-1/8 n	April 8, 1930
189	”	1/2 N-1/4 H-1/4 n	July 22, 1930
190	”	1/2 Hn-1/4 H-1/4 n	August 22, 1930
192	”	1/2 H-3/8 N-1/8 n	August 26, 1930
193	”	1/2 Hn-1/4 H-1/4 n	September 15, 1930
196	Male	7/8 N-1/8 n	October 22, 1930
205	Female	1/2 H-3/8 N-1/8 n	May 16, 1931
206	”	12/16 H-3/16 N-1/16 n	June 29, 1931
208	”	1/2 N-3/8 H-1/8 n	July 21, 1931
210	”	1/2 H-3/8 N-1/8 n	August 13, 1931
214	”	1/2 N-1/4 H-1/4 n	October 2, 1931

[a] H, Hereford; N, Nellore; Hn, Holstein; n, native.

TABLE 4

Showing the consumption of salt for four-week periods by the Nellore herd, based on the weight of animals

PERIOD	NUMBER OF MATURE ANIMALS	NUMBER OF YOUNG ANIMALS	EQUIVALENT NUMBER OF MATURE ANIMALS	TOTAL SALT CONSUMPTION	SALT CONSUMPTION PER HEAD
				kgm.	*kgm.*
Dec. 1 to Dec. 29, 1931	—	9	5.3	8.8	1.66
Dec. 29, 1931 to Jan. 26, 1932	—	9	6.7	5.4	0.81
Jan. 26 to Feb. 23, 1932	—	8	7.2	5.0	0.69
Feb. 23 to March 22, 1932	1	8	8.3	3.8	0.46
March 22 to April 19, 1932	1	8	8.2	4.4	0.54
April 19 to May 17, 1932	1	8	8.7	3.2	0.37
May 17 to June 14, 1932	1	8	8.4	3.9	0.46
June 14 to July 12, 1932	1	8	8.0	5.9	0.74
July 12 to August 9, 1932	1	8	7.7	7.6	0.99
August 9 to Sept. 6, 1932	1	8	8.1	5.3	0.65
Sept. 6 to Sept. 13,[a] Sept. 20 to Oct. 11, 1932	1	8	7.7	5.6	0.73
Oct. 11 to Nov. 8, 1932	1	8	8.0	6.3	0.79
Nov. 8 to Dec. 6, 1932	1	7	6.3	4.9	0.77
Dec. 6, 1932 to Jan. 3, 1933	1	8	7.1	2.0	0.28
Jan. 3 to Jan. 31, 1933	1	9	8.3	5.2	0.62
Average	—	—	7.6	5.2	0.70

[a] Consumption record from September 13 to 20, 1932, was not obtained owing to typhoon of September 15, 1932, which blew down the shed thus exposing the salt to the rain.

TABLE 5

Showing the consumption of salt for four-week periods by the Hereford herd, based on the weight of animals

PERIOD	NUMBER OF MATURE ANIMALS	NUMBER OF YOUNG ANIMALS	EQUIVALENT NUMBER OF MATURE ANIMALS	TOTAL SALT CONSUMPTION	SALT CONSUMPTION PER HEAD
				kgm.	*kgm.*
Nov. 28 to Dec. 26, 1931	3	6	7.5	13.8	1.84
Dec. 26, 1931 to Jan. 23, 1932	3	6	7.9	9.2	1.16
Jan. 23 to Feb. 20, 1932	3	6	7.7	8.7	1.13
Feb. 20 to March 19, 1932	3	6	8.0	8.3	1.04
March 19 to April 16, 1932	2	6	7.7	5.3	0.68
April 16 to May 14, 1932	2	6	8.6	2.6	0.30
May 14 to June 11, 1932	3	5	8.3	4.1	0.49
June 11 to July 9, 1932	3	5	8.6	6.3	0.73
July 9 to Aug. 6, 1932	3	5	8.1	6.6	0.82
August 6 to Sept. 3, 1932	4	5	8.6	5.1	0.59
Sept. 3 to Oct. 1, 1932	4	5	9.7	6.1	0.63
Oct. 1 to Oct. 29, 1932	4	5	9.3	7.7	0.83
Oct. 29 to Nov. 26, 1932	4	5	8.9	6.2	0.70
Nov. 26 to Dec. 24, 1932	4	5	9.5	4.5	0.47
Dec. 24, 1932 to Jan. 21, 1933	4	5	9.8	3.3	0.34
Average	—	—	8.5	6.5	0.78

TABLE 6

Showing the consumption of salt for four-week periods by the Grade herd, based on the weight of animals

PERIOD	NUMBER OF MATURE ANIMALS	NUMBER OF YOUNG ANIMALS	EQUIVALENT NUMBER OF MATURE ANIMALS	TOTAL SALT CONSUMPTION	SALT CONSUMPTION PER HEAD
				kgm.	*kgm.*
Jan. 1 to Jan. 28, 1932	6	14	13.7	18.3	1.34
Jan. 28 to Feb. 25, 1932	6	14	13.9	15.1	1.09
Feb. 25 to March 24, 1932	6	16	14.7	15.7	1.07
March 24 to April 21, 1932	6	17	15.5	14.6	0.94
April 21 to May 19, 1932	5	18	14.1	13.6	0.96
May 19 to June 16, 1932	6	17	15.6	11.9	0.76
June 16 to July 14, 1932	6	17	16.1	13.3	0.83
July 14 to Aug. 11, 1932	7	16	16.5	17.3	1.05
August 11 to Sept. 8, 1932	7	16	17.7	14.2	0.80
Sept. 8 to Oct. 6, 1932	6	16	16.2	12.2	0.75
Oct. 6 to Nov. 3, 1932	4	16	14.6	10.5	0.72
Nov. 3 to Dec. 1, 1932	4	15	14.6	9.9	0.68
Dec. 1 to Dec. 29, 1932	4	14	13.8	9.5	0.69
Dec. 29, 1932 to Jan. 26, 1933	4	14	13.6	11.0	0.81
Average	—	—	15.0	13.4	0.89

TABLE 7

Showing moisture content of salt before and after exposure to air

DATE	BEFORE EXPOSURE	AFTER EXPOSURE FOR ONE MONTH	MOISTURE ABSORBED DURING EXPOSURE FOR ONE MONTH
1932	*per cent*	*per cent*	*per cent*
February	11.14	14.74	3.60
March	10.35	21.18	10.83
April	8.09	10.14	2.05
May	10.35	17.97	7.62
June	14.35	37.27	22.92
July	12.12	44.82	32.70
August	11.15	36.96	25.81
September	13.01	39.40	26.39
October	13.16	43.93	30.77
November	11.41	47.04	35.63
December	11.18	46.47	35.29
1933			
January	9.79	39.51	29.72
Average	11.34	33.28	21.94

ABSTRACTS[1]

The comparative yields of cane and sugar per hectare under double-point and single-point methods of planting under Los Baños conditions. ONOFRE M. CASUPANG. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Agriculture from the College of Agriculture No. 476; Experiment Station contribution No. 1076.*)—The objects of this work were: (*a*) To find which will give the higher percentage of missing hills, the double-point or single-point method of planting; (*b*) to determine the comparative yields of cane and sugar per hectare of double-point and single-point methods of planting under Los Baños conditions.

In this study, the author used Luzon White. All cuttings, each having three to six nodes or eyes, were soaked in fresh running water for forty-eight hours, after which they were planted one to a hill, in the single-point method, and two to a hill, in the double-point method. The distance between hills was 50 centimeters and between rows was one meter. The whole field was cultivated and weeded five times; off-barred when the canes were about three months old and hilled-up about a month later. Under each method of planting, the percentage of missing hills, the relative vigor of the plants, susceptibility to disease and pests and the relative abundance of weeds, were observed and recorded. Also, the yield of cane and of sugar per hectare, and the approximate cost of labor and of planting materials were computed and recorded.

The author obtained the following results: The single-point planting had a higher percentage of missing hills than the double-point planting. There was an average of 20.80 per cent more missing hills in the single-point planting than in the double-point. The vacant hills provided spaces for the growth of weeds. The canes under both methods were observed to be practically free from disease. The canes under the two methods were of the same vigor. The plots with single-point planting were weedier than those with double-point planting. Double-point planting gave more cane and sugar per hectare than single-point planting. On an average, double-point planting gave 8.399 ± 4.969 tons cane and 14.479 ± 7.597 piculs sugar per hectare more than single-point planting. The single-point planting gave, however, a higher quality ratio than the double-point planting. Double-point required more labor and planting materials than single-point planting.

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[1] Abstracts prepared as a part of the required theme work in English 3a, College of Agriculture.

—Abstract by Arsenio P. Evangelista

Preliminary observations on the effects of withholding feeds from newly hatched chicks. GREGORIO A. MONEGAS. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 477; Experiment Station contribution No. 1077.*)—The objects of this work were: (*a*) To determine the influence on the initial weight of baby chicks of withholding feed and water; and (*b*) to determine the influence on the early growth of chicks of withholding feed and water.

The experiment was conducted from March, 1932 to January, 1933.

The author used 674 Los Baños Cantonese chicks from five hatches. Each hatch was divided into six similar lots. Lot 1 was given the first feed and water immediately on being taken from the incubator and the other lots were given the first feed and water as follows: Lot 2, after 24 hours, lot 3, after 48 hours, lot 4, after 72 hours, lot 5, after 96 hours, and lot 6, after 120 hours. Each lot was fed separately during the first four days of feeding, after which, the lots were combined.

The author obtained the following results:

The average loss per chick was 2.25 grams in 24 hours; 423 grams in 48 hours; 6.53 grams in 72 hours; and 8.87 grams in 96 hours. All chicks in lot 6 died before the end of the starving period of 120 hours.

Of the 125 chicks that were killed in each of lots 1 to 5 the average weights of the yolks removed were: 3.473 grams in unstarved (lot 1) and 2.634 grams after 24 hours of starvation, 2.060 grams after 48 hours, 1.320 grams after 72 hours, and 0.708 grams after 96 hours. The average daily loss in the weight of the yolk was 0.691 grams, which is 31.21 per cent of 2.22 grams, the average daily loss in the weight of the chick.

After 12 weeks the chicks that were starved for 72 hours had the highest average weight, with 425.42 grams; the chicks that were starved for 24 hours, second, with 373.39 grams; the chicks that were not starved, third, with 365.56 grams; and the chicks that were starved for 48 hours, fourth, with 347.24 grams. All chicks that were starved for 96 hours died before they were two weeks old.

Among the trials made, giving feed and water to baby chicks when they were 24 to 48 hours old proved to be the best treatment. It would seem from these results that newly hatched chicks could be transported profitably to any place that can be reached within 48 hours.

—*Abstract by Engracio Basio*

CURRENT NOTES

Less value is now attached to chemical analysis of the soil than was at one time the case, because its limitations are more fully realised. A beginner might think that he has only to get his soil analysed, and he will be able to supply manure which will fit it for growing any crops. The analyst can certainly determine accurately the total amounts of nitrogen, phosphates, and potash in the soil; but there is often little or no connection between these percentages and the soil's fertility or its manurial requirements. . . .

It is, therefore, by no means a simple matter to frame definite manurial recommendations on the results of analysis. It can only be done with confidence when the analyst is in possession of analytical figures for other soils of the same type in the same district, together with the results of manurial experiments carried out on those soils. Hence the importance now attached to soil surveys.

The Farmers' Gazette. (Ireland), August, 1935.

Agricultural holdings require to be consolidated to permit better farming practices which would lead to more uniform quality of produce and increased production.

When farmers more fully understand the use of agricultural credit instead of its misuse, more progress in the marketing of produce will be made.

Further improvements in quality and quantity of produce would be made if more attention was given to:

(a) The type of implements used.

(b) Selection of seed for planting.

(c) Control of pests and diseases.

(d) Application of the necessary cultural operations for the particular crop being grown.

Many areas are also planted with crops under conditions in which it is unremunerative to grow such crops. In Cyprus this particularly applies to cereal production where land is planted with wheat and barley which would be more profitably grown under olives and almonds.

The Cyprus Agricultural Journal, March, 1935.

It was suggested some time ago that the time would arrive when only good quality bananas of the better grades would consistently return payable prices to growers. This has been borne out in fact, and once again growers are urged to adopt all the recognised practices which will tend towards the production of fruit of the larger grades.

De-suckering or pruning is one of the most important operations and also one which is not put into practice as generally as it could be by growers. It should be commenced in young plantations as soon as the suckers are numerous and large enough to thin out, and it should be regularly performed afterwards.

The Agricultural Gazette of New South Wales, April, 1935.

A word in regard to the value of goat's milk. The T. B. Bacillus has not yet been found in goat's milk. This fact is one of great importance, more so as this dread disease is on the increase in India. Further the digestibility of goat's milk is much greater than that of cow's milk or buffalo's milk. Its value for dyspetics is shown by the fact that in New York, Chicago, and other large cities in the U. S. A. goats milk retails for twice the price of the best cow's milk, being in much demand for hospitals and sanatoriums.

The Allahabad Farmer, July, 1935.

The results obtained at Hawaii Experiment Station when 22 perfectly sterile staminate papaw (papaya) trees on being decapitated produced a new growth which was strictly feminine and the trees bore large fruits has now been confirmed at Jodhpur. From four plants all male, the cluster of leaves at the top were removed so that no auxillary male shoots might develop, and in all four cases strictly female trees resulted. One is bearing large fruits and the three others have produced female flowers.

Though according to some observers decapitation never produces the desired result, it should be tried before cutting down the male papaw. *Agricultural Bulletin, Bermuda, March,* 1935.

Reprinted from *The Journal of the Jamaica Agricultural Society,* May, 1935.

North Dakota reports 2,000,000 fewer acres infested with grasshopper eggs this season than in 1934, and the state has hope of soon conquering the pests.

Science News Letter, May, 1935.

COLLEGE AND ALUMNI NOTES

Dr. Jinshin Yamane of Taihoku Imperial University, Formosa, Japan, spent September 27 in the Department of Animal Husbandry familiarizing himself with the nature of the animal breeding work as carried out in the Department. According to Doctor Yamane, the results of experiments in Formosa and in the Philippines should be of mutual benefit owing to similarity of climatic conditions.

Mr. W. F. Jepson, entomologist of the Department of Agriculture in the island of Mauritius, accompanied by Mrs. Jepson, spent the time from July 10 to August 13 on the College Campus. Mr. Jepson is engaged in field exploration for natural enemies of white grubs from various countries for introduction into Mauritius against *Phytalus smithi* Arrow. This species was first noticed on that island, where it is believed to have been accidentally introduced from Barbados, in 1911. From a small focus of some 3000 acres, restricted around Pamplemousses, the pest rapidly spread to most of the sugarcane raising districts of Mauritius.

In Los Baños and vicinity Mr. Jepson was able to collect only a few scoliids, since they were quite rare at the time of his visit. On the island of Negros, however, his two-week collecting in the latter part of August was most encouraging, the result being successive shipments to Mauritius of lots totalling several thousand wasps, especially *Campsomeris quadrifasciata* Fabricius. Mr. and Mrs. Jepson left for Java and the other Dutch East Indian islands on October 3, after revisiting the College for a couple of days.

Dr. Sam F. Trelease formerly of our Plant Physiology Department, at present head of Department of Botany in Columbia University is engaged with Dr. James Curry in experiments on photosynthesis which, according to the Eastern United States daily press "may lead to solving farm problems by abolishing farms". In *Science*, Doctors Trelease and Curry in a preliminary report on their experiments write that: "The difference in rates of photosynthesis with heavy water and ordinary water cannot as yet be explained in terms of the mechanism of the reaction." . . . "But we are continuing our experiments with this object in view. The use of heavy water provides a new experimental approach to the problem of establishing a generally satisfactory theory for the mechanism of the photosynthetic process."

Dr. F. O. Santos, Professor and Head, Department of Agricultural Chemistry addressed the students in the School of Hygiene and Public Health, U. P. September 25 on the "Nutrition Problems of the Commonwealth." On October 4, he addressed the students in Cavite High School on "Foods for Filipinos."

The seventeenth anniversary of Loyalty Day in the College was observed on October 10. The usual plan for the day was followed, that is, College Parade, program in Baker Memorial Hall, faculty luncheon in Molawin Hall for guests, and athletic games in the afternoon. The only change was a Tea Dance in Molawin Hall instead of a general dance in the evening.

The parade was "pedestrian", no floats. This change was pronounced emphatically as a great improvement. The work of the College, both in intent and achievement has never been so effectively presented in a parade, and at much less expenditure of labor, time and money than when floats were used. The official judges awarded first place to Department of Entomology. Judging from comment this award was approved without a dissenting vote. Second place was awarded to School of Forestry. Many other sections were honorably mentioned by the judges. The program in Baker Hall follows:

"U. P. Beloved"	Audience
Invocation	Rev. Hugh Bousman
Welcome Address	Dr. Miguel Manresa
"Loyalty Song"	Audience
Introduction of the Guest of Honor	President Jorge Bocobo
Address	Vice Governor J. Ralston Hayden
Administration of Oath of Loyalty	Dean B. M. Gonzales
"Hail College Dear"	Audience

The two main lines of thought in Governor Hayden's most able address were on tradition and Mindanao as a land of promise for agriculturists. Tradition as fundamental to patriotism was the premise on the first. The recently approved Quirino-Recto Law on Agricultural Colonization and the prospects it holds out in Mindanao were forcibly set forth under the second topic.

President Bocobo in introducing Governor Hayden took occasion to pay a fine tribute to the Americans who in the last thirty-five years have given so freely of their best in government service in these Islands.

The program and all addresses are commended as emphasizing civil loyalty. Though the origin of the day, so to speak, was military the real motive in observing the day is to stress loyalty in a broader scope.

The one-hundred-and-sixth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Plant Physiology Building, College of Agriculture, on Thursday, September 26, 1935 at 7:30 o'clock in the evening.

The following papers were read and discussed.

"Flower behavior of avocados in the College of Agriculture with special reference to some promising varieties"
By Mr. A. V. San Pedro

"Development of heartwood in lanutan and narra"
By Mr. J. S. Ilustrisimo and Mr. F. O. Chinte

Paper was read by Mr. Ilustrisimo

"Preliminary trials on soil disinfection with formaldehyde and acetic acid dusts for control of damping-off of seedlings"
By Mr. E. F. Roldan

A short review course on subjects connected with sugar was offered in the College this year from September 25 to October 8. The course was planned to be of help to our graduates and others who were planning to take a special Civil Service Examination required of applicants for certain positions in connection with the Federal Administration of the Sugar Limitation Act.

Among the twenty or more who enrolled for the course were the following graduates of this College:

Raul Ruiz de Arana '35
Abelardo L. Bantug '34
Gerardo G. Capati '32
Porfirio R. Carandang '34
Hugo B. Fernandez '35
Cenon R. Flor Cruz '35
Severo J. Mariano '20
Toribio Mercado '30
Melquiades Pugeda '20
Celestino G. Reantaso '34
Narciso S. Sibal '34

Mr. Mariano Pamintuan '33 made a flying visit to the Campus in October to say "adios" before he sailed for the Near East and Europe. His plans are for eight months abroad. If he follows his plans, Mr Pamintuan will return with abundant riches that rust cannot corrode nor *anay* destroy.

Traditions are essential to the moral and spiritual life of any great institution. Beyond and behind the enacted laws of governments are the customs and traditions of peoples. Statutes that are out of harmony with the national way of life are difficult or impossible to enforce, and in most cases are of more than doubtful wisdom. Men and women willingly sacrifice their property and their lives for a country whose virtues have been made vivid to them through song and story extolling the noble deeds of the past and the greatness of their ancestors. Tradition, in short, is the stuff that national patriotism is made of.

Even more completely is tradition the basis of college spirit and college loyalty. Without traditions the institution of learning would command no more devotion from its students and alumni than does the factory from its employees. With high traditions deeply impressed upon its faculty and students, the college receives a loyalty that does not fade with youth, but binds its students to it with devotion that lasts throughout life.—VICE GOVERNOR HAYDEN in *Loyalty Day Address, College of Agriculture* (1935).

....Those who will not be starving in the years after graduation know *that it is not a diploma which is now at a premium, but the capacity for original thinking;* that education, while it may not assure one in advance a white collar job and a salary, will develop that enquiring mind which means, at least, opportunity.—*Syracuse Daily Orange.*

Reprinted in *What the Colleges are Doing*, January, 1935.

My books are water; those of the great geniuses are wine. Everybody drinks water. *From Mark Twain's Diary.*

Cosmopolitan, September, 1935.

"A good clerk but clock eyed."

IMPRESSIONS FROM A RECENT TRIP TO CHINA[1]

In the capacity of Exchange Professor of Plant Physiology from the University of the Philippines, in Lingnan University in Canton, China, I was in Southern China from March to June last year. While in that University I taught a combined laboratory and lecture course one semester in Plant Physiology and helped in planning or organizing the laboratory and in selecting the books, apparatus, equipments, and materials that would be needed in properly conducting the course. I gave also a series of lectures on coconut, abacá, jute and maguey (or sisal). I was a member of the Examining Board for two candidates for the degree of Master of Science and gave two special lectures: the first was at the Swasey Hall at one of the weekly convocations of the Student Body of the scientific and technical colleges, and the second was given before the Student Body of the Non-Collegiate School of Agriculture. I read a paper before the Lingnan Biological Seminar, and prepared a report on a three year plan of development of the course in Plant Physiology. Thus, my three months time in Lingnan was very well taken up by what may be called my "official" and "semi-official" work at the University.

But I appreciated that it was a part of my professional duty and certainly my personal desire to see all that I could outside the campus. In this paper I shall limit myself to just mentioning two or three of the famous noted buildings I saw and to describing more fully the new Sunyatsen University. Space does not permit some interesting ceremonies I was taken to see nor agricultural and economic observations.

Fortunately, I had for companions and guides in these "off-campus" trips Professor Koo Kwai Fan, Acting Dean of the College of Agriculture in Lingnan, and his wife and brother; Dr. Ira J. Condit, a visiting Professor in horticulture; and Professor Puiman Lee.

In our sight-seeing and field trips, we saw, among other things, the famous Flower Pagoda; the beautiful Sun Yat-sen Memorial Hall, which is said to have a seating capacity for five thousand and had cost over a million dollars (Canton) to construct it; the Sun Yat-sen

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[1] General contribution from the College of Agriculture No. 504. This is a part of a paper which was read before the Los Baños Biological Club on June 27, 1935.

Monument; the Five-Story Pagoda, now being used as a public museum. We also visited the huge and magnificent Canton City Hall. This structure, which is only half finished and construction still going on has already cost the city government more than one million dollars (Canton). Another pride of Canton is the Seventy-Two Heroes Monument, which was erected in honor of the seventy-two Cantonese whose lives were lost during the early part of the revolution that overthrew the Manchu dynasty in China. All of these historical monuments may be seen free of charge; but to visit the museum housed in the Five-Story Pagoda, a special permit is required and visitors are forbidden to carry a kodak or camera. These noted landmarks reveal the love of the Chinese people for beauty; each is an expression of Chinese architectural art and also an appreciation for patriotic deeds done for the common good of the people. Dr. Sun Yat-sen is the most revered of the Chinese patriots. His portrait may be found in every house and in every office in Canton. On Canton silver and paper money is the bust of this beloved son. He was born in Chun Shan, a village near Macao, in the province of Kwantung in which Canton is situated.

I was also able to visit the Five Hundred Buddhas, at present housed in a large building of one story in the heart of Canton. A small admission is charged. The five hundred life-sized statues are arranged in rows. No name was familiar to me except Marco Polo, that most famous of early travellers in Asia, especially in China. His early writings on his travels and experiences in China were considered by fellow Venetian townsmen as purely fabulous. When translated into other languages the reception was the same. "In England, school boys used the phrase 'It's a Marco Polo' to describe an incredible story. But Dr. Franklin P. Metcalf,[2] a botanist of note who has thoroughly studied the books and other writings of early travellers, found "in Marco Polo the most accurate and interesting book of travels of all time, a milestone in geography and a book which should have revalued and re-orientated all the inaccurate maps of the Orient then existing".

Of the two universities in Canton, the Lingnan University is a private Christian University with international faculty. Before the Revolution its name was Canton Christian College. It is a coeducational institution and consists of four colleges—Arts and Science, Agriculture, Business Administration, and Engineering. Also, it has various schools for students of lower than college attainments. The objective of the University, as its Trustees conceived it, is to have in Canton and adjacent territory in China "an institution of the highest standard of educational efficiency, under Christian influence." The National Sunyatsen University is a government institution also coeducational. It was founded by Dr. Sun Yat-sen several years ago in the city of Canton but in the last ten years or so the institution has been gradually moving its colleges and laboratories to the magnificent site just outside of the city. This new campus is large and of the shape of a bell. On it are located ideally the various colleges, laboratories and experiment stations. The dormitories for faculty members and for students, the library, the athletic field, and the swimming pool are on the same campus. This university consists of the College of Agriculture and Forestry, College of Sciences, College of Arts, College of Law, and College of Engineering. The aim and purposes for which this great university was established can be best given by citing some of the writings of its Founder, Dr. Sun Yat-sen and of its President, Dr. Chou Lou.

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[2] "Travellers and explorers in Fukien before 1700." Hongkong Naturalist 5: 252–271. 1934.

Doctor San Yat-sen in founding this university conceived that its function "is to coöperate with the government and extend its work in the various departments and faculties among the people." The relation of the University to the State and the People is stressed in the following statements by the Founder:

> It is incumbent upon the students to see this University (Sunyatsen) and the State and the People in due relation.
>
> The University must relate itself to the varied interests of the State, show the value of higher education to the commonwealth, educate public opinion, advance progress and maintain standards in all departments of life.
>
> Above all, let the University allow no baneful influence to degrade its lofty purpose and to destroy many of its useful and expert services to the State and Society.

According to President Chou Lou, "The chief aim in the founding of the University was to extend its interest to all questions of human welfare, culture, scientific research, social, political and all practical efficiency relating to the needs and the spirit of the time."

On a huge rock, "The Founder's Rock," which is located on the vast campus of the National Sunyatsen University, are carved in large Chinese characters some of the ideals of the very fertile mind of Dr. Sun Yat-sen. The thoughts were given verbally by this famous son of modern China to President Chou Lou, who, wrote them in Chinese characters some time in 1924. Translated for me by my good friend, Professor Puiman Lee of Lingnan University, the characters tell the faculty and the students and all others who read:

1. *To study extensively*
2. *To inquire inquisitively*
3. *To think thoughtfully*
4. *To examine carefully*
5. *To carry out faithfully*

Counsel, it seems to me, well worth pondering on—and following.

Besides the magnificent campus and many impressive buildings and laboratories that I saw in the National Sunyatsen University, I found other features worthy of note, and possibly worthy of imitation. I refer to the expressed policy or plan of making "the unproductive education self-supporting", that is, the extensive land owned by the University is being placed in a productive condition, largely by the College of Agriculture of which Forestry is a part, with the liberal appropriation of financial help which the University receives from the Central Government of China.

The University has planted some two million hills of bamboos and about the same number of forest trees, such as pines. Five years hence, five hundred thousand trees are expected to yield $1.00 (Canton) each, or $500,000.00. After another five years all the three million trees are expected to bring in an annual income of about $3,000,000 (Canton). To this large sum will be added the very considerable income to be derived from truck and dairy farming.

The College of Agriculture is in charge of the development of the extensive lands belonging to the University. Students of agriculture and students of forestry are thus given a splendid opportunity to watch the work or put into actual practice what they learn in the laboratories and class rooms. The University now owns and is developing the following areas:

Shihp'ai college farm	1,600	acres
Rice Experiment Station	14	"
Model Forest Station at the White Cloud Mountain	3,100	"
Sericultural Experiment Station	50	"
Land donated by the Government	66	"
Seed Breeding Station	10	"
Forest land set aside by the Provincial Government	3,400	"
Land grant from the Provincial Government	500	"
	8,734	acres

The Central Government of China appropriated the large sum of $20,190,000 for the development of the University on its present site, outside of the city of Canton. The appropriation was given to the University in three installments. All the construction work was expected to be completed last July. Before I left China in June, I visited the campus and some of its cultures and laboratories. The construction work that was then nearing completion was five or six large concrete buildings, and the impressive granite stone gate at the main entrance to the campus. It was all like a dream, a vision made into reality.

RAFAEL B. ESPINO
Of the Department of Plant Physiology

KING GEORGE AS A FARMER

His Majesty the King is identified closely, both by inclination and residence, with the farming industry.

Windsor, the traditional home of the Kings of England for centuries past, has always been a centre of the farming activities of the Royal House.

From the early centuries, when Windsor Forest was the hunting preserve of the reigning monarch, we come down to more recent times, when the Home Farms were established on more practical lines. At Windsor there are 175 cattle, 300 breeding ewes, a herd of Middle White sows, and about 1,000 head of poultry.

The cattle comprise pure-bred shorthorns, Herefords, Devons, Jerseys, and non-pedigree dairy shorthorns. The ewes are Border Leicester-Cheviot, crossed with a Southdown ram, and a large white boar is crossed with the middle white sows. Indian game cockerels are used with light Sussex hens in order to provide a good bird for the table.

All the milk, butter, and cream required for the Royal household while in residence at Buckingham Palace or Windsor Castle is sent from the royal farms every morning by road.

About 3,000 acres are farmed by the King at Sandringham, Norfolk, and on no estate in that country is the motto that "Property has its duties as well as its rights" more loyally or practically construed than at Sandringham, and no landowner possessing an estate of such magnitude within the county takes greater interest in its economy or is more conversant with every detail incident to its management.

At Balmoral in the Scottish Highlands, His Majesty has an excellent herd of Highland cattle, which has many victories to its credit. It is not, perhaps, given to this breed to obtain the supreme championship at the fat stock shows, but the King's herd of these picturesque, shaggy Highland cattle is invariably well forward in its breed classes, and has won the breed championship on many occasions both in Edinburgh and London.

Queensland Agricultural Journal, July, 1935.

MUSHROOM CULTURE IN CANTON [1]

A. N. BENEMERITO [2]
Of Lingnan University, Canton, China

WITH FIVE TEXT FIGURES

Mushroom culture is a profitable industry in Canton, China. If its culture is well understood and the climate is favorable, mushroom growing is one of the agricultural enterprises which gives a quick yield and a large profit. In view of promises of profit many Chinese have gone into the business of raising mushrooms. As rice straw is the most important material used in mushroom culture the price of rice straw in China is relatively high. In the Philippines where rice is the principal crop and the rice straw is usually left in the field to decay or sometimes burned as waste, mushroom raising could probably be carried out profitably. In mushroom culture in China one of the largest items of expense is the rice straw. In the Philippines, however, rice straw may be had at almost no cost except for the labor in cutting it and taking it from the field.

It is surprising that mushroom growing has not been developed as a business enterprise in the Philippines. The fact that edible mushrooms may be gathered from the thickets and forests in the Philippines is probably the reason that Filipinos have not taken the initiative in the industry. Also, a cause, which is also a result, is that mushrooms are not a common article of diet in the Philippines. Another reason is probably the lack of knowledge of mushroom culture among the farmers. It is the object of this paper to describe the method of raising mushrooms in Canton, China to give information on *Volvaria esculenta,* a mushroom, and its culture. It is hoped that the paper may form a useful guide for people who may wish to undertake the growing of this excellent food.

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[1] Miscellaneous contribution No. 14. Received for publication November 1, 1935.

[2] The author, a former student in the College of Agriculture, wishes to express his gratitude to Dr. F. P. Metcalf, Curator of the Lingnan University Herbarium and to Dr. Feliciano M. Clara, Plant Pathologist of the Bureau of Plant Industry, Manila for reading the manuscript and giving valuable suggestions, and to Mr. José Mendoza of the Bureau of Science, Manila for confirming the identification of the mushroom treated in this paper.

THE MUSHROOM CULTIVATED IN CANTON

Scientific and common names

The mushroom which is cultivated in Canton, China is *Volvaria esculenta* Bresadola (fig. 1 and 2). It was described by Bresadola[3] in 1912 from a specimen (Elmer 9937) collected by A. D. E. Elmer in Dumaguete, Negros, P. I.

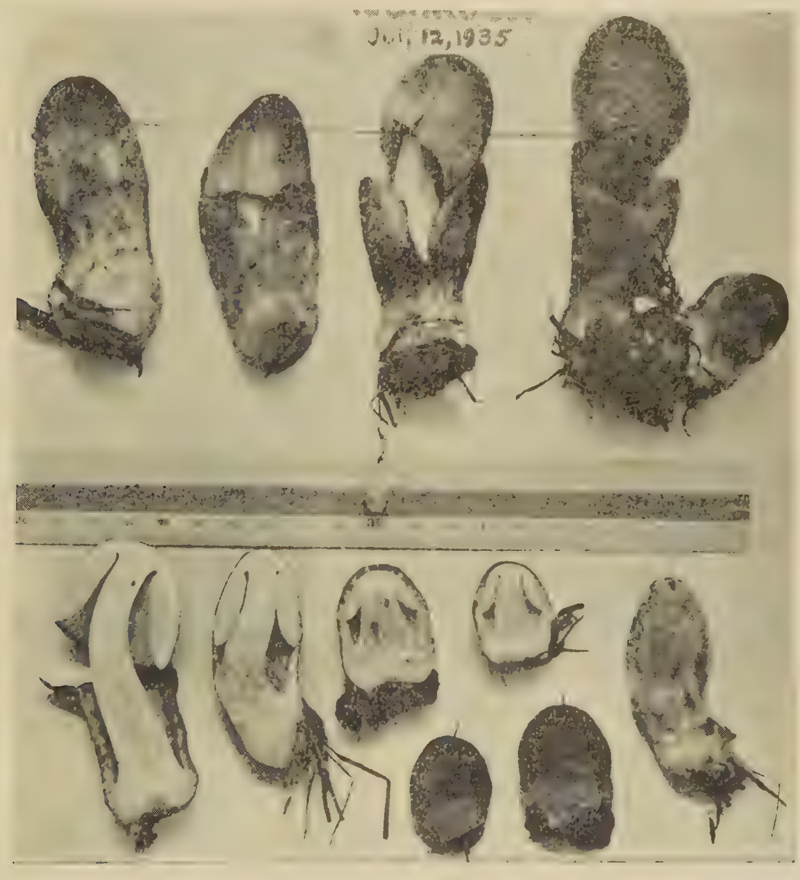

Fig. 1.—Young mushrooms, *Volvaria esculenta* Bres. showing different stages in development.

The English description of the mushroom, *Volvaria esculenta* Bres. is given by Brown (1921).

The common name of *Volvaria esculenta* in the Cantonese language is "Cho ku" and in the Philippines this mushroom is known as

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[3] Bresadola, J. 1912. Basidiomycetes Philippinenses. Serie I. Hedwigia 51: 306–326. Literature cited p. 309.

[4] Brown, William H. 1921. Minor products of Philippine forests. P. I. Bureau of Forestry Bulletin 22. Literature cited in 3: 126–130.

cabuti (Tagalog), *oong* (Ilocano and Pangasinan), *opong* (Visaya), *tobó* (Bicol), *payong-payong* (Pampango).

This species of edible mushroom is probably indigenous to Kwangtung Province, China. It is extensively cultivated in this region. That it grows wild in many parts of the Philippines shows that it is also probably native in that country or was introduced there very early.

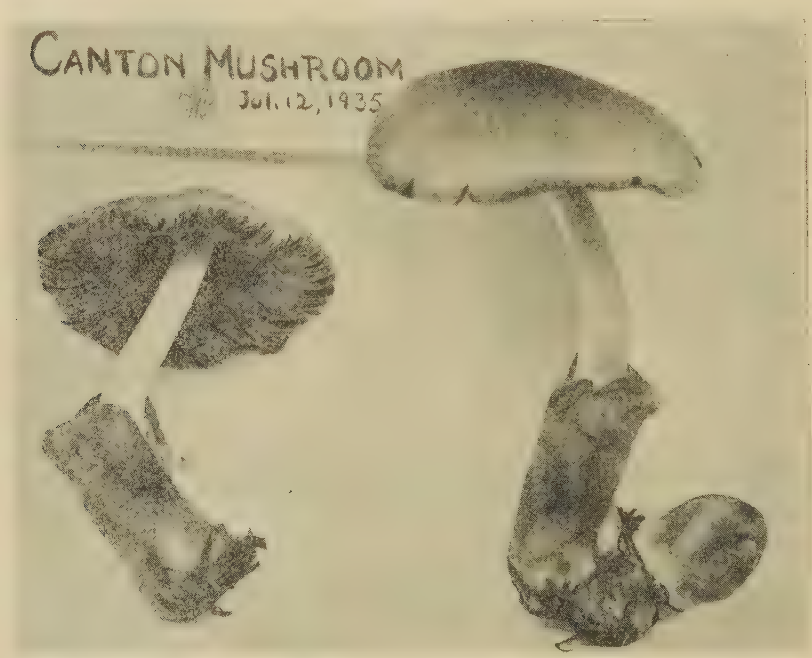

Fig. 2.—Mature *Volvaria esculenta* showing cap or pileus, stipe or stem and volva. The mushroom at left shows the lamellae.

Climatic requirements of Volvaria esculenta

The raising of mushrooms in Canton begins in the month of March or as soon as it is warm enough to start the culture out of doors. The production is carried on until the end of September or until the weather becomes too cold to allow culture in the open.

According to observations, the quantity of mushrooms produced is influenced by the amount of rainfall, the duration and intensity of sunshine, and temperature. When there is a heavy rainfall during the day, the quantity of mushrooms gathered the following day is small, and when the intensity of sunshine is too great the yield of mushrooms is also low. When the day is cloudy and warm the yield of mushrooms is high.

Under Canton conditions the yield of mushrooms is low during March and April when the temperature is still low. In May when the temperature becomes higher than that in March and April the production increases. During June and July the yield for the year is highest and then it gradually decreases in August and September, when the temperature begins to go down.

In the Philippines where the climate is warm almost the whole year round conditions would seem to be more favorable for the culture of mushroom than in Canton. Taking climatic conditions into consideration together with the abundance of rice straw and the commercial value of the product, there seems to be no reason why mushroom growing should not be carried on extensively in the Philippine Islands.

THE MEDIUM FOR MUSHROOMS IN CANTON

In the European method of growing mushrooms horse manure is used as a medium. In Canton, rice straw is practically the only medium used. Rice straw is used for growing the spawn, for making the beds out of doors and also for covering the beds after they are seeded.

In Canton when one goes into the raising of mushrooms, rice straw is the chief material to secure after a suitable piece of land on which to prepare the mushroom beds has been selected. Rice straw is often secured ahead of time and in order to reduce the cost of this material it is usually purchased during the rice-harvest time in July and October when the price is low. In the Canton region, the price of rice straw is from forty cents (Canton currency)[5] to over one dollar for every 100 catties (133 pounds), depending upon the time of the year when it is bought.

In the Philippines, experiments are said to be under way to test the use of abacá and banana waste for mushroom beds. In commercial mushroom growing the use of abacá waste may be profitable in the abacá-growing districts. In other regions in the Philippines perhaps rice straw will be found not only easy to obtain but also economical to use in mushroom beds.

In southern China the quantity of straw required by a mow (approximately 1/6 acre) of land devoted to mushroom culture is about 300 taams (39,900 pounds). If the price of a taam of straw is 40 cents (Canton currency), the cost of the straw required in a mow of land is $120.00 (Canton currency), if the straw is purchased at rice-harvest time. If the straw is bought after the harvesting season the cost is much higher.

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[5] One peso according to present rate of exchange is approximately one and a half Canton dollars.

In Kwangtung Province, it is a common practice, before the mushroom growing-season comes, to keep rice straw in piles on elevated ground in the home yard or on a high place in the field. The straw is piled in a conical stack with the top well covered so as to keep the rain from wetting the interior of the pile.

THE MUSHROOM SPAWN

At the end of the mushroom-growing season the spawn for the following year, consisting of portions of old mushroom beds, is placed under shelter to protect the fungus from perishing in the very low temperature which prevails in the winter. The spawn may be preserved by placing a thick cover of rice straw over it. If a greenhouse is available, it has been found wise to have the bed of spawn in it so as to keep the fungus alive so that there will be material ready for use when the mushroom-growing time comes in spring.

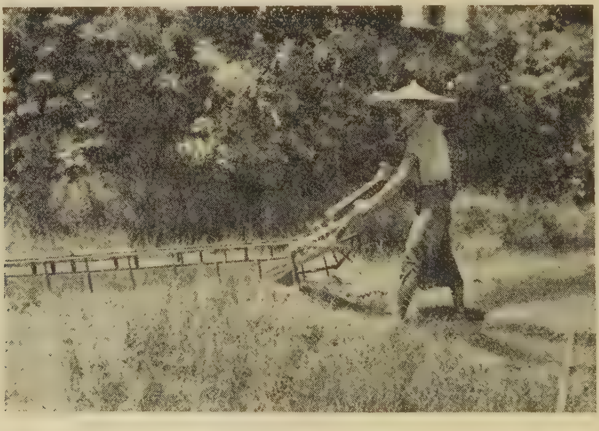

Fig. 3.—A Chinese workman irrigating with a pumping device a field for growing mushrooms.

The quantity of spawn needed to seed a mow of land varies from 12 to 30 taams, depending upon the thickness of planting the spawn in the beds. Under favorable conditions, the more spawn used, the larger the yield will be. As the quantity of spawn is very limited during the early part of the growing season, the tendency of the grower is to spread the spawn over a large area. In the second spawning more spawn is used in a given area of land because at this time there is usually an abundance of spawn and its price is lower than at the first planting.

In southern China the price of spawn varies from $4.00 to $15.00 (Canton currency) a taam (133 pounds). During the early part of the season, when there is but a limited supply of spawn the price is $15.00 a taam. As the season advances, however, the price may go down as low as $4.00 a taam or less. Because of the cost of spawn, it is the common practice in southern China to begin raising the mushrooms in a small piece of land and gradually to increase the size of the land as the supply of spawn increases.

According to the figures given above the cost of spawn required to seed a mow of land in Canton is from $120.00 to $180.00. During the early part of the season when the spawn sells at $15.00 a taam the total cost of spawn is $180.00. At this time 12 taams of spawn are used for each mow of land. Later in the season when spawn sells at $4.00 a taam, 30 taams are used in a mow of land. At this rate the total cost of spawn needed is $120.00.

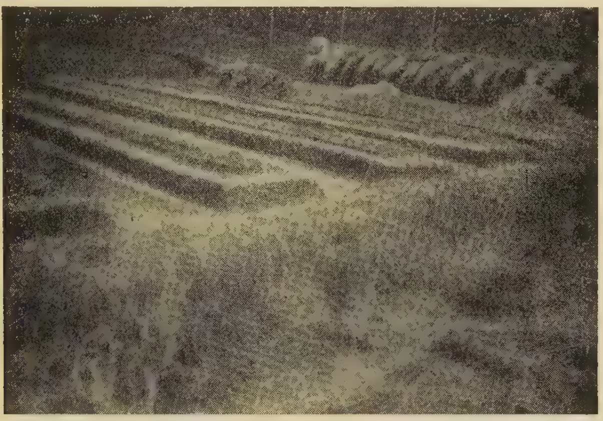

Fig. 4.—Prepared beds ready to be spawned. Note appearance of the bed at upper right hand corner; it is already spawned.

THE SITE FOR MUSHROOM BEDS

In Canton the site best suited for mushroom growing is near an irrigation system, a stream, river or where an abundance of water may be secured. Although too much water is injurious to the growing of mushrooms, without water its culture can not be accomplished.

In the Canton region, mushrooms are grown mostly in the lowlands where there is an abundance of water throughout the season. Although the tide reaches the mushroom-growing regions, the water is not salty. In the absence of rain the water is carried into the field by means of a wooden pumping device (fig. 3). In most cases, the level of the field is very much below the level of the water during the high tide. The field, however, is protected by a dike and this dike is provided with inlets and outlets. If water is needed, the inlet is opened during high tide and if water is not needed, the outlet is opened during low tide.

TOOLS AND EQUIPMENT

The tools and equipment required in mushroom culture are few. A hoe and a shovel are used in the preparation of the beds; a wooden vessel fitted with a bamboo handle for watering the mushroom beds; a wooden pumping device (fig. 3) for conducting water to the sides of the beds; and a straw basket for the gathering of mushrooms and taking them to market.

PREPARATION OF THE MUSHROOM BEDS AND SPAWNING[6]

The field is plowed and harrowed thoroughly to level the ground and destroy the weeds. The beds are made two and a half feet wide by any length. Usually, they are from 20 to 25 feet long. A path two feet wide is left between the beds (fig. 4). The beds are raised to about one-half of a foot high so that the water will easily drain off on rainy days.

At one end of the row of beds, a ditch about two feet wide and a foot deep is dug and the water is allowed to flow into it to facilitate watering the beds.

In the spring when the temperature rises to 20° to 25°C. the culture of mushrooms begins. In spawning a layer of rice straw about three inches or more in thickness, which had been softened by soaking in water, is spread lengthwise on the surface of the bed. This layer is trodden over by one man while another man pours water over it. A layer of spawn is then spread at the edges of the layer of straw. The process is repeated until six layers of straw alternating with spawn have been spread one on top of the other. After spreading a layer of spawn along the edges of the bed a layer of straw is spread over the spawn. A man treads on the layer of straw while another man pours water over it. Finally, a cover of straw is placed on the top of the bed. The straw used as cover is tied into small bundles before it is laid on the bed. Then an abundance of water is poured on the whole bed.

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[6] As a fully illustrated detailed description of the preparation of mushroom beds and spawning by Dr. Rafael B. Espino of this College will appear in the February issue of this journal this topic was condensed in this article.—EDITOR.

The cover, which is made of straw tied into small bundles (upper right hand corner of figure 4) is left on top of the bed for a week or so. Then the bundles are removed and soaked in water. After soaking, the bundles are untied and the straw is spread smoothly over the top of the bed forming a rounded top (fig. 5). An abundance of water is sprinkled on the bed.

CARE OF THE BEDS

After spawning (fig. 5) there is practically no care given to the beds except watering once a day when there is no rain. Watering is done late in the afternoon. In the absence of an irrigation system, water is carried from a well near by or from a pond.

THE CROP

In the Canton region, there are practically seven months in a year when mushrooms are cultivated. During these seven months three crops are raised. Each crop requires from sixty to seventy days from spawning to harvest.

Sixteen to twenty days after spawning, mushrooms appear and a crop may be gathered (fig. 1 and 2). The mushrooms are gathered usually early in the morning and are sent to the market. Those that are left in the morning or are not large enough are gathered in the afternoon.

From a piece of land under the writer's observation, having an area of three-fifths of a mow, the quantity of mushrooms gathered each day varied from fifteen to thirty catties. With this yield a mow of land may produce twenty-five to fifty catties of mushrooms a day. If a crop lasts forty days, the total yield of one crop is 1,000 to 2,000 catties of fresh mushrooms. If there are three crops of mushrooms a year, the total yield from a mow of land is from 3,000 to 6,000 catties. Under the most adverse conditions, there may be at least 2,000 catties of fresh mushrooms produced from a mow of land.

As stated in the beginning of this paper the quantity of mushrooms produced depends upon weather conditions. When there is a heavy rainfall during the day, the quantity of mushrooms gathered the following day is small and when the intensity of sunshine is too great the production is also low. When the day is cloudy and the temperature is favorable the yield is high.

During the spring when there may be a cold breeze the beds are covered with additional straw cover to protect the young mushrooms. As soon as the danger from cold winds is over the additional straw cover is removed.

DISPOSING OF THE MUSHROOM CROP

In the early part of the season when mushrooms are scarce, there is a great demand for them although the price is high. As the season advances, there is a gradual increase of supply which may become so abundant that the price may reach a very low mark. In Canton, mushroom growers generally supply hotels and restaurants with mushrooms. If the supply is more than the demand the rest of the crop is dried in the sun and sold as dry mushrooms. In the villages where the market is far away the growers find it advantageous to dry the mushrooms and keep them in this condition until the price improves. (Dried mushrooms are imported from China into the Philippines and sell for around seven pesos a kilogram.)

The price of fresh mushrooms varies from forty cents or less to over a dollar a catty, depending upon the supply. If the yield of a mow of land is 2,000 catties and the selling price of a catty is forty cents, it may be seen that the total income from the mushrooms produced is $800.00.

COST OF PRODUCTION OF MUSHROOMS

For the information of those who may be interested in mushroom growing the following data on cost of production based on Canton conditions are given:

Cost of production of a mow of land (*1/6 acre*). It has been estimated that a mow of land requires 300 taams of rice straw. At a cost of 40 cents a taam the total cost of the rice straw needed for a mow is $120. For spawn, it is estimated that 12 taams are required to seed a mow of land. At the rate of $10 a taam the total cost of spawn is $120. For labor, a mow of land requires at least one man to take care of it. Under conditions in Canton the man receives a wage of $30 a month. For the seven months of the mushroom-growing season the total cost of labor is $210. The rent of land is estimated at $25. The miscellaneous expenses are estimated at $100. From these figures it may be seen that the total amount invested, excluding interest, is $575.

Income. It has been estimated that the yield of a mow of land is 2000 catties of fresh mushrooms, the usual price is 40 cents a catty. At the estimated yield, the income from land would be $800 and the total expenses, $575 which would leave a net income of $225.

Remarks. From these estimates, it may be seen that mushroom culture is a profitable agricultural enterprise in the Canton region. In fact it is considered one of the most profitable.

SUMMARY

1. Mushroom culture is a profitable industry in Canton, China. The mushroom cultivated is *Volvaria esculenta* Bres. This species is widely distributed in the Philippines. In the Cantonese language this mushroom is known as "Cho ku" and in the Philippines it is known under the dialect names *cabuti* (Tagalog), *oong* (Ilocano and Pangasinan), *ojong* (Visayan), *tobó* (Bicol), *payong-payong* (Pampango).

The mushroom growing season in Canton begins in March and ends in September. The highest yield is obtained during June and July when the temperature is high. The yield of mushrooms is influenced by rainfall, duration and intensity of sunshine and temperature.

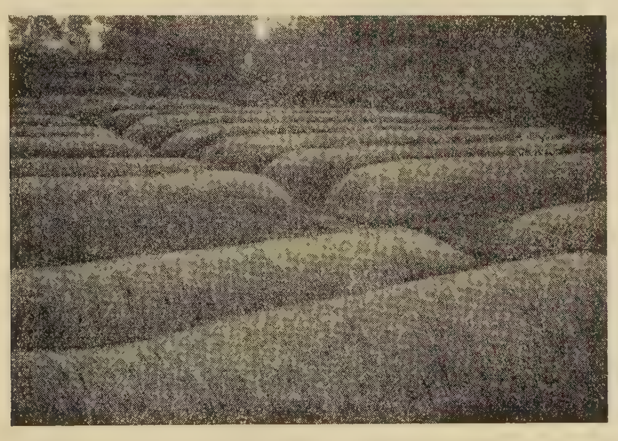

Fig. 5.—The appearance of the mushroom beds two weeks after spawning.

Rice straw is practically the only material used for preparing the medium of the mushroom in southern China. A mow of land for mushroom beds (approximately 1/6 acre) requires about 300 taams (39,000 pounds) of rice straw. If purchased at rice-harvesting season a taam of rice straw costs 40 cents (Canton currency). If rice straw is secured later the price is much higher than at rice harvesting time when it is abundant.

During the winter season the spawn of *Volvaria esculenta* in Canton is kept well protected from the effects of very low temperatures. The spawn required for seeding a mow of land varies from 12 to 30 taams. The cost of the spawn varies from $4 to $15 (Canton currency) a taam, depending upon the supply.

In the Canton region mushrooms are raised in the lowlands where there is an abundance of water for watering the beds throughout the season.

The mushroom beds are usually two and one-half feet by 20 to 25 feet with a path two feet wide between them. The beds are raised one-half of a foot high.

The tools needed in mushroom culture are few and simple.

The preparation of the beds for seeding with the spawn, the spawning and the care of the beds are described in the paper.

Three crops are harvested during the mushroom-growing season. A crop requires 60 to 70 days to grow. The first crop of mushrooms may be harvested 16 to 20 days after spawning.

The yield of a mow of land in a year varies from 3,000 to 6,000 catties and the net profit from the crop may be approximately $225 (Canton currency).

STUDIES ON THE PHYSICAL QUALITIES OF THE HEN'S EGG: III. INFLUENCE OF AGE AND SEASONAL CHANGES ON THE RATE OF LOSS OF WEIGHT OF LOS BAÑOS CANTONESE EGGS[1]

F. M. FRONDA AND D. D. CLEMENTE

WITH TWO CHARTS

The weight of an egg is the sum of the weights of the shell and shell membranes, the albumen and the yolk. Extensive studies have been made to determine the factors that influence this particular character of eggs, (Curtis, 1914; Benjamin, 1920; Hays, 1929; Funk and Kempster, 1934), but the studies on the extent to which eggs maintain their weight under ordinary room conditions are limited. As eggs are commercially graded on the basis of weight, investigations along this line are important. To be able to know how much weight eggs lose during the period of holding should be not only of interest but of value to poultry producers.

Dunn (1922-23) observed that the rate at which eggs lose weight is one of the most variable of all egg characteristics. Greenlee (1911) stated that the loss of weight in unincubated eggs is probably due to the evaporation of water in the dryer atmosphere. Curtis (1914) showed that there were individual differences in the amount of weight lost by eggs kept under identical conditions; and Dunn (1922-23) observed that among fowls, there is a marked individuality in the rate at which their eggs lose weight. Dunn stated further that this difference is probably not due wholly to variations in the shells or other egg envelopes, but to a combination of such morphological causes and other variable physiological processes.

In the same study, Dunn reported that in twenty-four hours the average loss of weight of eggs placed in a storage cellar at 50°F. (10°C.) ranged from 0.06 to 0.27 per cent, with an average of 0.135 per cent. In twenty days, eggs placed under similar conditions varied in loss of weight from 1.30 to 4.28 per cent, the average being 2.07 per cent of the fresh weight. In another study, Dunn (1923a) observed that larger eggs lost more actual weight, although a smaller proportion of their weights than smaller eggs. He claimed that a large egg has less evaporating surface in relation to its weight than a small egg, and the larger the egg the more impervious its shell. Hence, larger eggs are apparently better able to conserve their moisture content than smaller ones.

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[1] Part of the expenses incurred in this study were paid from a research grant by the Philippine Poultry Association. The data presented in this paper were taken from the thesis prepared by the junior author for graduation, March, 1933, with the degree of Bachelor of Science in Agriculture No. 478; Experiment Station contribution No. 1079. Received for publication July 10, 1935.

Numerous reports have been written regarding the loss of weight of eggs under incubation temperatures. Jull (1930) cited the works of Gilbert (1894), Graham (1906), Eycleshymer (1907), Louise (1911), and Atwood (1901), the results of which show that under natural conditions of incubation, fertile eggs lose approximately 10 to 17 per cent of their original weight. Dunn (1922-23) reported that under normal incubation temperatures, 190 pullet's eggs with an average of 56.41 grams were found to lose, on an average, about 3.17 grams in the first seven days of incubation, and 33 hen's eggs under similar conditions lost 3.13 grams; each lot lost 5.61 per cent of their fresh weight. In fourteen days of incubation, the average loss of weight was 10.67 per cent of the fresh weight. In this connection, Dunn stated that the rate of evaporation probably decreases slightly in the second seven days of incubation. According to Jull (1930), as the developing embryos give off carbon dioxide and absorb oxygen in progressively increasing amounts as incubation progresses, loss in weight of incubating eggs is not due wholly to evaporation of the water content, although this is the principal contributing factor.

No work has been published on determining the rate at which eggs held under ordinary room conditions lose weight. To what extent this rate is influenced by age and by seasonal changes is another question that should be of interest not only to producers but also to consumers of this essential commodity. To answer these two questions, this study was made.

PLAN OF THE STUDY

From November, 1931 to October, 1932, 175 new-laid Los Baños Cantonese eggs were set aside each month. Thus, there were twelve sets of observations made, each set covering a period of 100 days. The period covered in each observation was as follows:

SET NO.	BEGINNING	ENDING
1	November 13, 1931	February 21, 1932
2	December 11, 1931	March 19, 1932
3	January 10, 1932	April 18, 1932
4	February 15, 1932	May 24, 1932
5	March 13, 1932	June 20, 1932
6	April 12, 1932	July 20, 1932
7	May 12, 1932	August 19, 1932
8	June 8, 1932	September 15, 1932
9	July 14, 1932	October 21, 1932
10	August 7, 1932	November 14, 1932
11	September 9, 1932	December 17, 1932
12	October 6, 1932	January 13, 1933

These eggs were laid by the College flocks that received the regular College laying ration composed of mash that consisted of one part by weight of either shrimp meal or fish meal or meat scrap, as the animal protein supplement, three parts of copra meal, two of corn meal, and four of rice bran, and grain that consisted of equal parts of corn and palay (unhusked rice). The eggs were weighed individually in an analytical balance. They were then placed in shallow boxes, 50 cm. long, 35 cm. wide and 10 cm. deep, and were well padded with excelsior. The boxes were placed on a table in the Poultry Laboratory. Every three days, thereafter, five eggs, taken at random, were weighed. The eggs were turned once a day in transferring them from one box to another.

The first weight of the egg or the "initial weight" as used in this paper is the weight of the egg on the afternoon of the day it was laid. The eggs were gathered and brought to the laboratory some time during the day and were weighed immediately. The weighing was finished in the evening, and in no case was the initial weight of the eggs taken later than in the first twenty-four hours after they were laid.

After weighing each egg, the volume was determined with the specially constructed set of apparatus described by Fronda and Clemente (1934). The volume was determined to find the effect of age on the specific gravity of the egg.

The temperature and the relative humidity of the room in which the eggs were kept were recorded. The temperatures to which the eggs of different ages were subjected were determined as follows: For the three-day old eggs the average temperature was found by adding temperatures for those days and dividing the sum by 3. For the six-day old eggs the temperatures for the first six days were added and the sum divided by 6. This process was repeated for the rest of the eggs. The same process was used for determining the average of the relative humidity.

RESULTS AND DISCUSSIONS

Influence of age on the rate of loss of weight of eggs. The amount of loss of weight of eggs of different ages held in November under laboratory conditions are given in table 1 and presented graphically in chart 1. By reference to this table and to chart 1, it may be seen that the longer the eggs were held, the greater the amount of weight lost. A three-day old egg lost 0.202 gram of its weight or 0.49 per cent, but a twelve-day old egg lost 0.957 gram or 2.25 per cent, of its weight. The total amount of weight lost by a ninety-nine-day old egg was 6.185 grams or 16.46 per cent of its weight. These figures should be of interest to producers, particular-

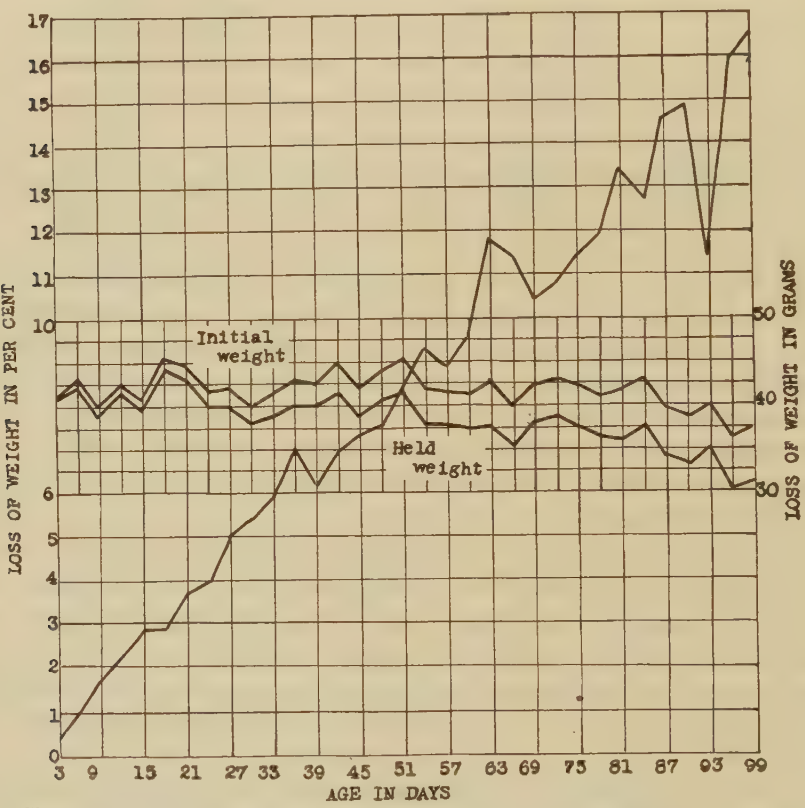

Chart 1.—Curves showing the amount of loss of weight of eggs held at different ages under laboratory conditions in November.

ly those who sell their eggs by weight. By holding an egg for six days under conditions similar to those under which these observations were made, as much as 0.430 gram or 1.00 per cent of its weight will be lost, and the longer the egg is held, the greater will be the amount of weight lost. It may be stated in passing that the eggs observed were held under ordinary laboratory conditions from November 13, 1931 to February 21, 1932.

Is the rate of loss influenced by the age of the egg? To answer this question, the amount of weight lost by the eggs was reduced to the daily basis. It was observed that on this basis the loss ranged from 0.049 to 0.085 gram, or 0.123 to 0.195 per cent, a day (see table 1). The average for the ninety-nine days was found to be 0.070 gram or 0.167 per cent.

By examining the figures given in table 1, it may be observed that there was an apparent tendency for the eggs to lose weight regularly and a little more rapidly in the first fifteen days of holding than later; after this period, the rate of loss was maintained for a time and then gradually decreased and became irregular as the eggs became older. For instance, an egg held for three days lost an average of 0.163 per cent of its weight per day, one held for fifteen days, 0.187 per cent, for thirty days, 0.177 per cent, another for forty-five days, 0.163 per cent, for sixty days, 0.160 per cent, for seventy-five days, 0.151 per cent. After seventy-five days, the tendency is for the rate of loss to increase again. Thus, a ninety-day-old egg lost 0.164 per cent of its weight a day.

As may be seen from table 1, there are exceptions to this generalization. This may be expected for, in the first place, the eggs observed were not of the same size, and Dunn (1923a) observed that larger eggs lose a smaller proportion of their weight than smaller eggs. Furthermore, there is a marked individuality in the rate at which eggs kept under identical conditions lose weight, as reported by Curtis (1914) and Dunn (1922-23). There are other factors, also, that influence the loss, as differences in the thickness of the shell and the variation in the number of pores of the shell, as shown by Holst and Almquist (1931) and Dunn (1923b).

The influence of seasonal changes on the rate of loss of weight of eggs. The foregoing discussions were based on eggs held from November 13, 1931 and included the months of November, December, January and part of February. These months are comparatively cooler than the other months of the year. Table 2 gives a summary of the percentages of loss of weight of eggs held during the different months of the year.

By reference to table 2, it may be seen that the rate of loss of eggs held under ordinary room conditions varied according to the season of the year in which they were held. From the data obtained in this study, it may be stated that the eggs that were held during the warm months of the year lost more weight than those held during the cooler months. The total loss during the ninety-nine days of holding varied from 16.46 per cent in the November set to 27.22 per cent in the March set. The latter set included the months of March, April, May and part of June; these months are the hottest of the year.

The figures in table 2 show that the losses of weight of three-day-old eggs varied from 0.36 per cent in the July set to 0.97 per cent in the December set. The records show that the room temperature in July was 27.13°C. in December, 25.14°C. High room temperatures were recorded in April, 28.29°C., in June, 28.56°C., and in November, 28.38°C. The amount of losses in weight during these months were: April, 0.66 per cent; June, 0.47 per cent; and November, 0.49 per cent. The relative humidity recorded in April was 80.0 per cent; in June, 76.8 per cent; and in November, 88.4 per cent. Low room temperatures were observed the first three days in January, and in February; in January it was only 25.15°C., and 24.61°C. in February. The rate of loss of weight of three-day-old eggs in these months was 0.56 per cent in January and 0.42 per cent in February. It is apparent from these figures that there are other factors besides climate that influence the rate of loss of weight of eggs.

Considering the losses during the early days of holding, it may be seen that the amount lost during the first fifteen days ranged from 2.44 per cent in the December set to 5.01 per cent in the April set. The room temperature recorded for the fifteen-day-old eggs in the December set was 24.94°C.; in the April set, 28.93°C. The loss of 4.41 per cent in the weight of the eggs in the May set followed that of the April set, and the room temperature recorded in May was 28.48°C. Both the January and February sets were held in room temperatures that were fairly low, 23.94°C. in January and 24.86°C. in February. The loss of weight of the fifteen-day-old eggs in January was 2.60 per cent, and of the February set, 3.46 per cent.

The average percentage of loss of weight of eggs at different ages held during February, May, August, and November, four representative months of the year, are graphically presented in chart 2. The average of the observation made during the twelve months is plotted, together, for comparison, with the figures obtained during these four representative months. By reference to this chart, it may be seen that the influence of climatic conditions upon the rate at which eggs lost weight is very marked.

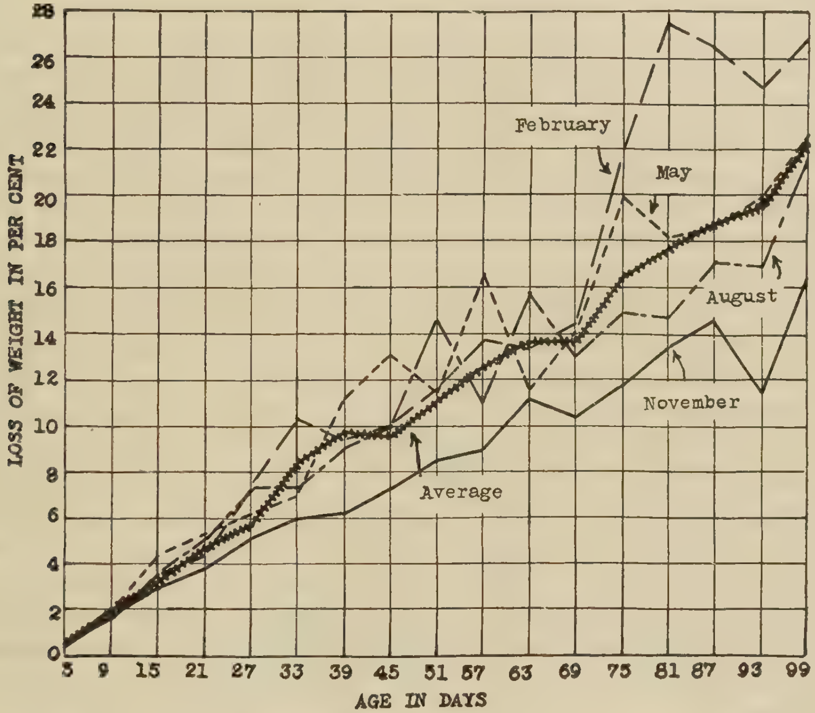

Chart 2.—Curves showing the comparative rate of loss of weight of eggs held under laboratory conditions during February, May, August, and November.

The November set was held during the coolest months of the year,—November, December, January and a part of February. These months happened to be fairly moist also during the time the observations were made. The curve of the losses of weight of the eggs held these months is therefore very low. On the other hand, the curve of the February set of eggs is very high. These eggs during the first twenty-four days of holding were held under fairly cool room conditions, but after this period, the room conditions became warmer and the atmosphere, dryer. The climatic conditions during which the May and August sets were held were practically the same, in both room temperature and relative humidity.

Undoubtedly, climatic factors strongly influence the rate at which eggs that are being held lose in weight, but the other influencing factors, pointed out in the preceding discussions, should also be considered. Greenlee (1911) who made extensive studies on the relation of temperature to evaporation concluded, after a series of experiments, that the rate of change of water content in eggs increased with high temperature.

The figures obtained in this study show that there is a relation also between the relative humidity of the atmosphere and the rate of loss of weight of the eggs held, although this relationship is not as clearly shown as that of the relationship between temperature and loss of weight. The relative humidities at the time the November, December, January, February, and March sets were observed were much higher than the relative humidity during the time the April to October sets were run. The loss of weight of the eggs in the first group of sets was generally less than the loss of weight of the eggs in the second group of sets.

The highest relative humidity was recorded for the November set and the lowest for the July set, but the losses of weight in these sets were not the highest and the lowest. The loss of weight in the July set, however, was higher than that of the November set, showing more or less the relationship of the relative humidity and loss of the weight. The rate of evaporation in eggs seems to follow inversely the relative humidity of the atmosphere, when this is low, the rate of loss of weight is high, and when the relative humidity is high the rate of loss of weight is low. This relation is in agreement with the former explanation between the relation of temperature to evaporation.

It is of interest to note that the average loss of weight of eggs in every three days, from the fresh eggs to the twelve-day-old eggs constantly increased from 0.545 per cent to 0.649 per cent. This tendency shows that as the eggs become older the average rate of evaporation for each succeeding day increased up to the twelfth day. This rate may be due to the increased openings of the pores owing to the disintegration of the cuticle as the eggs become older, as pointed out by Holst and Almquist (1931). From the fifteen-day to the ninety-nine-day-old eggs the average losses of weight in every three days were not regular. The variation in the number of pores and the time the cuticle disintegrated, the variation in the thickness of the shells, the difference in the relative humidity and temperature might have been the causes responsible for the variations in the loss of weight. Dunn (1922-1923; 1923a; 1923b) found that the causes in the variation in the loss of weight in eggs were differences in temperature and relative humidity to which the eggs are subjected, size of the eggs, porosity of the egg shells, and thickness of the shells.

Changes in the specific gravity of eggs due to age. Although it is not quite within the scope of this paper, the changes of the specific gravity of eggs as influenced by the length of holding were observed, this being closely related to weight. Table 3 shows the changes in the specific gravity of the eggs as related to age. As may be seen from the data obtained, there was a general tendency for the specific gravity to decrease as the eggs became older.

By reference to table 3, it may be seen that the specific gravity of new-laid Los Baños Cantonese eggs varied from 1.058 to 1.068. Fronda and Clemente (1934) observed that even newly laid eggs produced during the same month varied in specific gravity, but Fronda, Clemente, and Basio (1935) observed that the specific gravity of eggs laid during the different months of the year followed a definite tendency, depending upon the season of the year in which the eggs were laid. The rate, however, at which eggs that were held under laboratory conditions during different months decreased in specific gravity, varied considerably. For instance, taking the months of February, May, August, and November, it may be seen, by reference to table 3, that the May set of eggs had the lowest specific gravity after fifteen days of holding, and the August set had the highest. The February and November sets had about the same specific gravity when fifteen days old, that is, 1.019 for the February set and 1.018 for the November.

It is interesting to note also that at the age of fifteen days, the specific gravity of the eggs observed varied from only 1.001 in the April set to 1.058 in the October set, the average for all the twelve months being 1.027. At this age, only the eggs in the January, July, August and October sets had specific gravities that were higher than the average; the eggs in the sets in the other months had lower. At the age of thirty days, the specific gravity of the eggs averaged only 0.992, the range being from 0.962 in the April set to 1.022 in the October set. Sixty-day-old eggs held under ordinary room conditions averaged only 0.938 in specific gravity; the range was from 0.881 in the March set to 0.975 in the October set. It was observed that at the age of ninety-nine days, the specific gravity of the eggs studied ranged from only 0.764 to 0.883, the average obtained from the observations made during the different sets being 0.825. At this age, the highest specific gravity was recorded in the October set, followed by the sets of November, December, July, August and September in the order named. The lowest specific gravity was recorded in the February set, followed by the March, June, May, January and September sets. From these figures it may be concluded that the rate of decrease of specific gravity of eggs held during the cooler months of the year was less than that of eggs held during the warmer months.

Here, again, variations and exceptions may be noted. The increase in loss of weight as the eggs became older was primarily responsible for the decreased specific gravity since the volume of an egg remains constant. Normal variations in the specific gravity of fresh eggs as observed by Fronda and Clemente (1934), and by Fronda, Clemente, and Basio (1935), together with the variations in the loss of weight, may account for the exceptions in the general tendency of the specific gravity to become lower as the eggs became older. The variation in the loss of weight of the eggs of the same ages from different sets was observed to be related to the variation in the specific gravity of the eggs of the same ages of different sets. When the averages for the twelve sets were found the tendency of the specific gravity to decrease, as related to age, was more uniform than in any of the sets shown in table 3.

SUMMARY OF CONCLUSIONS

The results of studies on the influence of age and seasonal changes on the rate of loss of weight of eggs are reported in this paper. The results may be summarized as follows:

1. It was observed that the longer the eggs were held, the greater the amount of weight lost.

2. An apparent tendency was observed for the eggs to lose weight a little more rapidly during the first few weeks of holding than later.

3. It was observed that the rate of loss of weight of eggs held under laboratory conditions varied according to the season of the year in which they were held.

4. Eggs held during the hot, dry months of the year lost more weight than those held during the cooler and more moist months.

5. The relationship between the relative humidity of the atmosphere and the rate of loss of weight of eggs held is shown, but

this relationship is not as clearly marked as between temperature and loss of weight.

6. Apparently, there are also factors other than climatic conditions that influence the rate of loss of weight of eggs in holding.

7. A general tendency was observed for the specific gravity to decrease as the eggs became older.

8. The rate of decrease in the specific gravity of held eggs depends upon the season of the year, being more rapid during the hot months than during the cool months.

9. The data obtained in this study seem to show that the rate of loss of weight of eggs is high when the relative humidity of the atmosphere is low, and when the relative humidity is high, the rate of loss of weight is low.

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TABLE 1

Showing the rate of loss of weight of eggs of different ages

AGE	WEIGHT		DECREASE		DECREASE	
	Initial	After holding	Total	Av. per day	Total	Av. per day
days	*grams*	*grams*	*grams*	*grams*	*per cent*	*per cent*
3	41.160	40.958	0.202	0.067	0.49	0.163
6	43.081	42.651	0.430	0.072	1.00	0.167
9	39.992	39.297	0.695	0.077	1.74	0.193
12	42.400	41.447	0.957	0.080	2.25	0.187
15	40.820	39.677	1.143	0.076	2.80	0.187
18	45.609	44.322	1.287	0.071	2.82	0.158
21	44.687	43.020	1.667	0.079	3.73	0.178
24	41.672	40.004	1.668	0.069	4.00	0.167
27	42.056	39.947	2.109	0.078	5.01	0.185
30	40.160	38.024	2.136	0.071	5.32	0.177
33	41.376	38.943	2.433	0.074	5.88	0.178
36	43.178	40.125	3.053	0.085	7.07	0.195
39	42.592	39.967	2.625	0.967	6.16	0.158
42	44.851	41.736	3.115	0.074	6.94	0.165
45	41.952	38.877	3.075	0.068	7.33	0.163
48	44.107	40.769	3.338	0.069	7.57	0.158
51	45.544	41.715	3.829	0.075	8.41	0.165
54	42.069	38.147	3.922	0.073	9.32	0.173
57	41.408	37.726	3.682	0.065	8.89	0.156
60	41.477	37.494	3.983	0.066	9.60	0.160
63	42.675	37.626	5.049	0.080	11.83	0.188
66	40.028	35.471	4.557	0.069	11.38	0.173
69	42.452	38.028	4.424	0.064	10.42	0.151
72	43.454	38.753	4.701	0.065	10.82	0.150
75	42.234	37.442	4.792	0.064	11.35	0.151
78	41.137	36.223	4.914	0.063	11.94	0.153
81	41.661	36.085	5.576	0.069	13.38	0.165
84	42.950	37.478	5.472	0.065	12.74	0.152
87	39.751	33.979	5.772	0.066	14.52	0.167
90	38.755	33.024	5.731	0.064	14.79	0.164
93	39.891	35.340	4.551	0.049	11.41	0.123
96	36.404	30.631	5.773	0.060	15.86	0.165
99	37.577	31.392	6.185	0.062	16.46	0.166

TABLE 2

Showing the average percentages of loss of weight of eggs held at different ages during the different months

AGE OF EGGS	NOV. SET	DEC. SET	JAN. SET	FEB. SET	MARCH SET	APRIL SET	MAY SET	JUNE SET	JULY SET	AUG. SET	SEPT. SET	OCT. SET	AVERAGE
days	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
3	0.49	0.97	0.56	0.42	0.46	0.66	0.45	0.47	0.36	0.48	0.63	0.59	0.545
6	1.00	1.17	0.84	0.99	1.18	2.30	1.28	0.73	0.93	1.52	0.71	1.22	1.156
9	1.74	1.78	1.79	1.63	1.91	3.34	1.98	1.84	1.45	1.68	1.65	1.85	1.887
12	2.25	2.48	1.80	3.34	2.48	2.89	2.92	3.44	2.16	2.90	1.96	2.55	2.597
15	2.80	2.44	2.60	3.46	2.71	5.01	4.41	3.71	2.47	3.58	2.59	2.72	3.208
18	2.82	3.38	2.50	4.59	2.82	6.98	4.24	3.68	2.96	5.08	4.57	3.00	3.885
21	3.74	3.59	3.95	4.41	4.50	7.16	5.31	6.51	3.73	5.06	3.93	4.41	4.692
24	4.01	3.39	4.49	5.39	6.31	7.63	4.55	4.38	5.22	5.59	4.65	4.52	4.555
27	5.01	4.20	4.22	7.38	9.63	9.07	6.13	6.26	4.94	7.34	4.03	5.87	5.612
30	5.32	4.67	5.86	6.42	7.59	9.11	7.53	7.12	6.46	7.98	5.67	4.72	7.371
33	5.88	6.68	4.89	10.42	9.02	10.02	7.01	7.40	9.97	7.27	6.82	4.88	8.355
36	7.07	6.36	6.32	8.34	11.14	9.54	8.37	6.39	9.22	9.11	6.79	6.35	7.917
39	6.16	6.23	5.86	9.44	9.46	13.28	11.21	7.44	8.92	9.08	6.40	11.41	8.741
42	6.94	7.18	8.68	10.99	10.36	10.97	10.72	7.60	8.44	11.10	7.63	12.26	9.406
45	7.33	6.13	6.53	10.01	10.33	11.28	13.24	9.54	12.73	9.93	8.93	9.73	9.642
48	7.57	8.51	8.63	11.79	16.44	13.08	13.81	11.39	11.71	10.12	8.66	10.00	10.976
51	8.41	9.20	8.05	11.64	13.16	14.46	11.48	9.99	11.36	14.63	9.23	8.93	10.878
54	9.32	7.56	10.56	12.32	17.28	15.08	11.25	11.08	12.78	11.37	11.32	11.48	11.783
57	8.89	7.88	9.85	13.76	17.99	17.91	16.56	10.91	14.69	11.15	10.33	10.61	12.544
60	9.59	11.56	11.68	14.13	18.24	13.69	13.13	15.30	13.66	14.23	9.98	8.26	12.764
63	11.83	10.08	13.11	13.36	18.87	19.20	11.59	10.07	14.41	15.77	10.68	14.99	13.663
66	11.38	10.41	11.98	14.92	19.53	17.45	15.55	14.60	16.20	12.64	11.25	10.62	13.877
69	10.42	11.12	16.02	14.41	18.26	17.06	13.99	12.17	14.47	13.06	11.42	10.96	13.613
72	10.81	11.95	16.50	17.54	19.88	18.72	15.79	14.58	18.90	16.74	12.95	12.98	15.612
75	11.34	13.73	16.70	21.71	18.66	21.72	19.87	16.84	14.38	15.25	16.36	11.61	16.514
78	11.94	13.65	14.72	16.97	20.47	18.02	17.52	17.49	18.66	14.56	14.54	11.74	15.857
81	13.38	14.18	18.57	27.51	22.05	20.27	18.22	17.06	18.57	14.65	14.18	13.40	17.678
84	12.74	18.58	15.79	22.15	20.43	20.94	17.80	15.67	16.81	19.90	15.38	12.91	17.425
87	14.52	15.63	21.92	26.40	21.39	19.43	18.57	21.93	16.71	17.08	15.54	15.12	18.687
90	14.79	17.49	17.69	27.84	21.52	18.23	22.78	24.37	15.49	16.58	17.06	14.77	19.051
93	11.41	16.35	19.37	24.72	25.54	24.24	20.08	26.07	18.62	16.82	16.92	15.22	19.613
96	15.86	14.71	24.76	26.66	23.86	22.98	17.71	25.04	21.52	19.51	18.14	20.09	20.003
99	16.46	18.49	24.37	26.88	27.22	24.08	24.41	21.74	22.65	21.60	22.29	17.02	22.267

TABLE 3

Showing the average of specific gravities of eggs held at different ages during the different months

AGE OF EGGS	NOV. SET	DEC. SET	JAN. SET	FEB. SET	MARCH SET	APRIL SET	MAY SET	JUNE SET	JULY SET	AUG. SET	SEPT. SET	OCT. SET	AVERAGE
days													
Newly-laid	1.058	1.067	1.068	1.063	1.062	1.063	1.068	1.061	1.067	1.068	1.068	1.072	1.066
3	1.037	1.048	1.055	1.056	1.058	1.038	1.051	1.058	1.047	1.062	1.071	1.055	1.053
6	1.027	1.040	1.055	1.061	1.038	1.031	1.036	1.039	1.044	1.033	1.048	1.038	1.041
9	1.024	1.037	1.051	1.047	1.027	1.013	1.032	1.028	1.043	1.043	1.051	1.067	1.039
12	1.022	1.030	1.047	1.011	1.022	1.032	1.025	1.027	1.025	1.033	1.031	1.047	1.029
15	1.018	1.033	1.036	1.019	1.025	1.001	1.011	1.014	1.043	1.041	1.022	1.058	1.027
18	1.015	1.028	1.041	1.011	1.031	0.971	1.022	1.021	1.024	1.007	1.006	1.019	1.016
21	1.012	1.017	1.030	1.013	0.992	0.981	1.012	0.997	1.033	1.010	1.009	1.040	1.012
24	1.001	1.003	1.021	1.009	0.985	0.974	1.012	1.004	1.009	0.991	1.008	1.028	1.004
27	0.994	1.016	1.029	0.988	0.965	0.955	1.016	0.999	1.016	0.986	1.014	1.000	0.998
30	0.987	1.011	1.012	0.994	0.987	0.962	0.986	0.976	0.983	0.982	1.005	1.022	0.992
33	0.985	0.988	1.016	0.953	0.965	0.951	0.989	0.997	0.977	0.985	0.992	1.013	0.984
36	0.966	1.002	1.002	0.979	0.948	0.956	0.977	0.984	0.961	0.973	0.999	0.998	0.979
39	1.003	1.010	0.998	0.965	0.943	0.930	0.942	0.980	0.980	0.951	1.001	0.937	0.970
42	0.996	1.002	0.965	0.977	0.945	0.934	0.948	0.972	0.969	0.944	1.005	0.935	0.966
45	0.994	1.006	0.994	0.968	0.944	0.931	0.934	0.966	0.920	0.945	0.962	0.959	0.960
48	0.979	0.980	0.971	0.955	0.882	0.956	0.933	0.967	0.939	0.959	0.978	0.963	0.955
51	0.976	0.978	0.976	0.941	0.923	0.914	0.967	0.939	0.955	0.909	0.967	0.985	0.947
54	0.958	0.986	0.963	0.928	0.906	0.892	0.966	0.954	0.950	0.931	0.941	0.961	0.945
57	0.966	0.977	0.969	0.918	0.869	0.875	0.886	0.889	0.905	0.946	0.957	0.954	0.926
60	0.959	0.935	0.959	0.909	0.881	0.921	0.933	0.966	0.938	0.911	0.965	0.975	0.938
63	0.940	0.968	0.940	0.907	0.870	0.885	0.935	0.895	0.899	0.897	0.974	0.910	0.918
66	0.942	0.931	0.947	0.908	0.882	0.869	0.913	0.907	0.884	0.954	0.938	0.953	0.919
69	0.957	0.944	0.899	0.900	0.879	0.895	0.930	0.910	0.912	0.967	0.957	0.965	0.926
72	0.959	0.934	0.896	0.879	0.881	0.878	0.895	0.883	0.861	0.892	0.949	0.952	0.905
75	0.948	0.912	0.876	0.827	0.854	0.831	0.895	0.895	0.914	0.932	0.935	0.963	0.898
78	0.934	0.921	0.915	0.882	0.863	0.855	0.882	0.829	0.853	0.909	0.909	0.966	0.893
81	0.942	0.926	0.877	0.790	0.840	0.838	0.870	0.901	0.875	0.925	0.952	0.935	0.889
84	0.937	0.844	0.895	0.907	0.851	0.836	0.866	0.833	0.891	0.867	0.927	0.938	0.883
87	0.912	0.905	0.816	0.774	0.847	0.851	0.877	0.802	0.898	0.887	0.906	0.921	0.866
90	0.902	0.953	0.879	0.752	0.851	0.791	0.813	0.786	0.891	0.901	0.887	0.925	0.861
93	0.950	0.908	0.862	0.796	0.793	0.816	0.856	0.792	0.901	0.897	0.875	0.918	0.864
96	0.895	0.941	0.812	0.800	0.804	0.814	0.871	0.835	0.833	0.864	0.868	0.849	0.849
99	0.872	0.871	0.809	0.764	0.791	0.811	0.804	0.801	0.837	0.835	0.820	0.883	0.825

INFLUENCE OF TEMPERATURE AND MOISTURE ON THE VIABILITY OF SOME VEGETABLE SEEDS[1]

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Several kinds of vegetable seeds that are planted in the Philippines are imported. The keeping of these seeds viable for a period of reasonable length after their arrival in the Islands is an important factor in vegetable growing, as their cost is rather high and they rapidly deteriorate when kept under ordinary conditions. That seed storage, seed testing, and other questions pertaining to seed are matters of concern in other countries is evidenced by the amount of literature published on these subjects. Judging by this standard, little work on vegetable seed storage has been done in the Philippines. It was with the aim of accomplishing something along this line that this study was undertaken in the Division of Pomology, Department of Agronomy, College of Agriculture from November 6, 1932 to July 15, 1934.

A perusal of the literature on the storage of vegetable as well as other seeds show that among the factors affecting seed viability, moisture and temperature are the most important. Maquenne (1902) stated that the seeds he studied retained their germinative faculty much longer when thoroughly dried and kept in vacuum than when exposed to open air. Duvel's works (1904, 1904-1905) are of particular interest because he studied vegetable seeds. In his study (1904) of the storage of sweet corn, onion, cabbage, radish, carrot, pea, bean, watermelon and lettuce seeds he found that the viability of the seeds was directly proportional to the amount of rainfall in the district where they were stored, the injury becoming more pronounced as the temperature became higher. In another experiment (1904-1905), he used sealed and open bottles and packages with a known moisture content as containers and different storage temperatures. He established a close relationship between the loss in viability and the increase of moisture, the effect again increasing with rise in temperature.

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[1] Experiment Station contribution No. 1080. Received for publication August 28, 1935. The subject of this work was suggested by Dr. Leon G. Gonzalez of the Department of Agronomy and the work was carried out while the writer was connected with that department.

Nesom (1907) reported an experiment on the storage of seed corn in the Philippine Bureau of Agriculture. He stated that heating the seeds to drive out the moisture previous to storing them between layers of powdered charcoal gave much better results than simply hermetically sealing the seeds in ordinary seed canisters or glass containers. The work of Heinrich (1913) on several species of seeds showed that although the hygroscopic water content of the seeds was high they will retain their viability if fresh air is admitted to them in storage, better than when ventilation is not provided. Previous drying of the seeds did not prolong their life if they were ventilated, but if air was excluded, previous artificial drying even at a high temperature (30°C.) greatly lengthened their viability. Without exception, a low temperature (under 5°C.) favored the viability of seeds stored for a long period, even if they contained a large amount of hygroscopic moisture. In his work on coniferous seeds, Tillotson (1921) virtually confirmed the results of Duvel (1904, 1904-1905) on vegetable seeds. He obtained the best germination from seeds stored in localities with high altitudes and low relative humidity. Guillaumin (1923) reported that dryness and reduction of air pressure prolonged the germinability of seeds. Hoffman (1925) proved that moist heat is more injurious than dry heat to seeds of Noble and Silver fir, Western White pine and Douglas fir. Moodie (1925) observed that seeds in transit stored under cool conditions with slight temperature variation retained their viability better than seeds stored under warmer conditions with great variations of temperature.

MATERIALS AND METHODS

Seeds of cabbage, *Brassica oleracea* var. *capitata* Linn. variety All Head Early; carrot, *Daucus carota* Linn. variety Chantenay; lettuce, *Lactuca sativa* Linn. variety Grand Rapids; pechay, *Brassica cernua* (Thumb) Forbes and Hemsl.; native radish, *Raphanus sativus* Linn.; sitao, *Vigna sesquipedalis* Fruw.; parsley, *Petroselinum hortense* Linn. variety Fern-leaved; garden bean, *Phaseolus vulgaris* Linn. variety Kentucky Wonder; tomato, *Lycopersicum esculentum* Mill. variety Marglobe; and native eggplant, *Solanum melongena* Linn. were used in these experiments. The cabbage, carrot, lettuce, parsley, tomato and Kentucky Wonder bean seeds were obtained from W. Atlee Burpee Co. of Philadelphia, Pennsylvania, U. S. A. The pechay and radish seeds were bought from the Bureau of Plant Industry, Manila. The seeds of sitao and eggplant were produced in the Agronomy Department of the College of Agriculture.

Before beginning the experiments the seeds of one variety were thoroughly mixed, and one hundred were counted out at random for determining the percentage of germination. The remaining seeds were divided into eight lots; each lot was placed in a properly labeled coin envelop. The packets containing the seeds that were to be given one kind of treatment were placed together in a 15-centimeter by 20½ centimeter cylindrical glass museum jar with a ground glass cover, rubber ring and iron clamp. In case the treatment called for dry storage a 3-centimeter layer of anhydrous calcium chloride was placed in the bottom of the jar and a piece of coarse cabinet wire, cut to fit, was put on top of the calcium chloride to separate the seeds from it. For the control, no calcium chloride was used. The edge of the jar and the cover were smeared with vaseline to insure a tight fit with the rubber ring when clamped.

The storage chambers used were the same as those used by the writer with lanzones (1932) and described by Campo (1935). Four temperatures were used in the experiment, 0° 10° –13,°, 20°–22° and 27.5°–28°C. These temperatures were maintained during the progress of the experiments in the manner described by the writer in his earlier work.

One hundred seeds of each species and treatment were tested for viability from time to time, with the exception of Kentucky Wonder beans of which only fifty were used. In the first three tests the seeds were germinated between two sheets of blotting paper. Later, filter paper fitted inside Petri dishes was substituted for the blotting paper. The germinating medium was kept moist during germination tests. Beginning on the third day, the germinated seeds were counted and removed from the medium every day. A point was made of opening the jars stored at 0° and 10°C. last, in order that they might acquire the room temperature before they were opened, thereby preventing condensation of moisture on the packets and seeds.

EXPERIMENTS AND RESULTS

Two experiments are covered by this report. The first was performed from December 5, 1932 to July 15, 1934, covering a period of 588 days. In this experiment seeds of cabbage, carrots, lettuce, parsley, pechay, radish and sitao were used. All the seeds were stored with calcium chloride, the idea being to determine the influence of different storage temperatures on the viability of the seeds stored in a dry atmosphere. Germination tests were made at the beginning and at the end of 213 days, 339 days, 438 days and 588 days in storage. The results are presented in table 1 and summarized in table 2.

The second experiment, in which Kentucky Wonder beans, eggplant, lettuce, pechay and tomatoes were used, was begun on November 6, 1933 and concluded on July 15, 1934, covering a period of 312 days. In this experiment some seeds were stored with calcium chloride and others without it with the object of determining the influence of moisture on the viability of seeds stored at different temperatures. The influence of temperature on seeds stored in moist atmosphere was also determined. The percentage of germination was determined at the beginning and at the end of 162 days and of 312 days in storage. The results of this experiment are shown in table 3.

DISCUSSION

Influence of temperature. The rather inconsistent results which gave statistically insignificant differences between the percentages of germination of the seeds stored at different temperatures, as shown in tables 1 and 2, seem to point to little or no effect of the storage temperature on the viability of the seeds studied when these were stored over calcium chloride. Cabbage is possibly the only exception; it showed a slightly significant difference between the germination of seeds stored at 0° (80.00 ± 3.10 per cent) and 27.5°–28° (57.60 ± 5.15); those stored at 10°–13° and 20°–22° showed no significant difference nor, was the difference significant when each was compared with those stored at 0°. The findings of Maquenne (1902), Nesom (1907), Heinrich (1913), Guillaumin (1923) and Vibar and Rodrigo (1929), also point to the little influence of the storage temperature on germinability if the seeds are well dried and hermetically sealed.

Without calcium chloride, (table 3) the storage temperature of beans, eggplant or tomato had little effect during the first 162 days in storage; but it had an appreciable effect on lettuce and pechay, the 0° storage temperature giving the least deterioration. After 312 days in storage, however, the results were rather conclusive in showing that with all seeds studied; namely, beans, eggplant, lettuce, pechay and tomatoes, the deterioration increases with rise in temperature. Thus, in the case of beans, those stored at 0° gave 82 per cent germination, those at 10°, 40 per cent; those stored at 20°–22° and 27.5°–28° gave only 5 per cent germination. Lettuce, pechay and tomatoes gave similar significant results.

Influence of moisture. Table 3 shows that after 162 days in storage the beans did not seem to be affected either favorably or unfavorably by the removal of moisture; lettuce and pechay showed a marked benefit from it. Tomato and eggplant, on the other hand, were very slightly adversely affected by calcium chloride. After 312 days in storage, however, the beneficial effect of calcium chloride was significantly shown by all the seeds, with the exception of tomato, which did not show either negative or positive results. Duvel (1904, 1904-1905) and Tillotson (1921) also found that the germinability of the seeds they studied was indirectly proportional to the humidity of the localities where they stored them. The case of the tomato which was not appreciably benefited by calcium chloride may be a distinct species reaction. In a study of certain forest seeds, Clemens (1911) found that the reaction of the seeds to storage conditions varied according to species. For example, a controlled temperature of 2°–3°C., with the moisture and carbon dioxide removed, as formed, proved better than keeping the seeds in a dry room subjected to ordinary fluctuations of outside temperature in the case of the fir, oak, beech and maple, while pine, cypress and ash gave either inconclusive or negative results.

Relative effects of temperature and moisture. From table 3 it appears that with seeds in storage, moisture is more detrimental than temperature. In other words, dry-warm storage is better than moist-cool conditions for preserving seeds. Taking the germination of beans after 312 days in storage as an example, seeds stored with calcium chloride at 0° gave 84 per cent; 10°–13°, 82 per cent; 20°–22°, 80 per cent; and 27.5–28°, 82 per cent germination, all showing insignificant differences. Seeds stored without calcium chloride gave the following percentages of germination; 0°, 82 per cent; 10°–13°, 40 per cent; 20°–22°, 0 per cent, and 27.5°–28°, 0 per cent. A comparison of the seeds stored at the same temperatures with the humidity as the variable factor shows the greater influence of humidity. It should be noted also from the figures cited above, which are typical for the other seeds studied, that the deleterious effect of moisture increases with rise in the storage temperature. The results of the germination test after 162 days in storage show similar tendencies, although not so marked.

The results in these studies may be taken as an explanation of the common experience of obtaining fairly good germination from seeds that are thoroughly dried before they are hermetically sealed in cans or glass containers, even when they are stored under ordinary temperatures.

SUMMARY

Results of experiments on the storage of seeds of cabbage, carrots, lettuce, pechay, radish, sitao, parsley, Kentucky Wonder beans, eggplant and tomatoes are presented and discussed. The influence of the storage temperature and moisture on the viability of the seeds was determined by storing different lots of seeds at 0°, 10–13° 20–20°, and 27.5–28°C., with and without calcium chloride, and testing their germinability at intervals. The results show that the viability of the seeds stored with calcium chloride were not significantly affected by the storage temperature as compared with those stored at higher temperatures; there was one exception, cabbage which showed a significant benefit when stored at 0°. When stored without calcium chloride the results up to 162 days did not show very much influence of the storage temperature. After 312 days in storage, however, the results conclusively show that beans, eggplant, lettuce and pechay deteriorate in direct proportion to the storage temperature.

The seeds of beans, eggplant, lettuce and pechay all showed significant benefit from the use of calcium chloride at all the storage temperatures tried. Tomato seeds were not benefited by calcium chloride.

Of the two factors (temperature and moisture), it seems that moisture exerts more influence on the viability of the seed than temperature. Hence, for practical purposes, it is recommended that for storing the vegetable seeds studied, moisture should be removed with calcium chloride. If this is not possible the seeds should be thoroughly dried and while still warm hermetically sealed in glass or tin containers. In case the seeds are not thoroughly dry, effort should be made to store them at a temperature as close to 0°C. as possible.

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TABLE 1

Influence of temperature on the viability of seeds stored with calcium chloride

	GERMINATION AT BEGINNING (DEC. 5, 1932)	GERMINATION AFTER 213 DAYS (JULY 6, 1933)				GERMINATION AFTER 276 DAYS (SEPT. 6, 1933)			
		0°	10°—13°	20°—22°	27.5—28°	0°	10°—13°	20°—22°	27.5—28°
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Cabbage	90	93	93	84	88	69	62	67	49
Carrot	65	57	54	54	62	53	48	54	46
Lettuce	63	37	38	35	31	18	22	22	25
Parsley	56	57	45	50	57	41	42	34	39
Pechay	99	96	94	91	94	91	90	89	75
Radish	85	67	64	48	42	42	43	37	39
Sitao	93	79	78	75	70	72	71	59	56

	GERMINATION AT BEGINNING (DEC. 5, 1932)	GERMINATION AFTER 339 DAYS (NOV. 8, 1933)				GERMINATION AFTER 438 DAYS (FEB. 15, 1934)			
		0°	10°—13°	20°—22°	27.5—28°	0°	10°—13°	20°— 22°	27.5— 28°
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Cabbage	90	72	71	63	53	78	66	61	48
Carrot	65	57	51	45	42	58	53	36	55
Lettuce	63	61	51	55	50	42	49	54	41
Parsley	56	32	32	31	28	55	58	59	56
Pechay	99	91	89	86	89	87	85	87	80
Radish	85	23	24	27	9	0	0	0	0
Sitao	93	83	77	81	80	71	75	77	82

TABLE 1 (Continued)

	GERMINATION AT BEGINNING (DEC. 5, 1932)	GERMINATION AFTER 588 DAYS (JULY 15, 1934)			
		0°	10°—13°	20°—22°	27.5—28°
	per cent	*per cent*	*per cent*	*per cent*	*per cent*
Cabbage	90	88	67	55	50
Carrot	65	56	43	39	53
Lettuce	63	36	26	20	36
Parsley	56	44	46	38	46
Pechay	99	94	85	87	82
Radish	85	0	0	0	0
Sitao	93	71	62	70	37

TABLE 2

Summary of table 1 showing the averages of germination tests of seeds stored with calcium chloride at the same temperatures

Seeds	0°	10°—13°	20°—22°	27.5°—28°
	per cent	*per cent*	*per cent*	*per cent*
Cabbage	80.00 ± 3.10	71.80 ± 3.70	66.00 ± 3.30	57.60 ± 5.15
Carrot	56.20 ± 2.11	49.80 ± 1.34	45.60 ± 2.51	51.60 ± 2.36
Lettuce	38.80 ± 4.63	37.20 ± 3.95	37.20 ± 5.07	36.60 ± 2.89
Parsley	45.80 ± 3.12	44.60 ± 2.81	42.40 ± 3.52	45.20 ± 3.63
Pechay	91.80 ± 1.03	88.60 ± 1.14	88.00 ± 0.60	84.00 ± 2.27
Radish	26.40 ± 6.58	26.20 ± 6.24	25.40 ± 3.54	18.00 ± 5.00
Sitao	75.20 ± 1.65	72.60 ± 1.94	72.40 ± 2.56	65.00 ± 5.61

TABLE 3

A comparison of the viability of the seeds stored with and without calcium chloride ($CaCl_2$), at different temperatures

SEED	GERMINATION AT BEGINNING (NOV. 6 1933)	GERMINATION AFTER 162 DAYS (FEB. 15, 1934)										
		0°		10°—13°		20°—22°		27.5°—28°		Average		
		With $CaCl_2$	No $CaCl_2$	With $CaCl_2$	No $CaCl_2$	With $CaCl_2$	No $CaCl_2$	With $CaCl_2$	No $CaCl_2$	With $CaCl_2$	No $CaCl_2$	Difference
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Beans	94	90	90	92	100	96	98	90	94	92.00 ± 0.95	95.50 ± 1.57	3.50 ± 1.83
Eggplant	58	54	59	39	54	48	54	40	56	42.25 ± 2.40	55.75 ± 0.83	13.50 ± 2.54
Lettuce	78	63	61	65	50	64	54	67	57	64.75 ± 0.58	55.50 ± 1.57	9.25 ± 1.67
Pechay	82	84	74	86	71	80	62	89	50	84.75 ± 1.36	59.75 ± 4.49	25.00 ± 4.90
Tomato	75	63	73	69	66	63	68	60	73	63.75 ± 0.88	70.00 ± 1.20	6.25 ± 1.48

SEED	GERMINATION AT BEGINNING (NOV. 6 1933)	GERMINATION AFTER 312 DAYS (JULY 15, 1934)										
		0°		10°—13°		20°—22°		27.5°—28°		Average		
		With $CaCl_2$	No $CaCl_2$	With $CaCl_2$	No $CaCl_2$	With $CaCl_2$	No $CaCl_2$	With $CaCl_2$	No $CaCl_2$	With $CaCl_2$	No $CaCl_2$	Difference
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Beans	94	84	82	82	40	80	0	82	0	82.00 ± 0.55	30.50 ± 10.19	51.50 ± 10.21
Eggplant	58	43	39	49	12	38	5	39	5	42.25 ± 1.84	15.25 ± 1.72	17.00 ± 2.52
Lettuce	78	61	19	64	1	60	0	67	3	63.00 ± 1.07	5.75 ± 2.79	57.25 ± 2.97
Pechay	82	78	12	61	5	52	12	48	3	64.25 ± 3.08	8.00 ± 1.58	56.25 ± 3.46
Tomato	75	61	69	62	63	54	43	53	48	57.50 ± 1.57	55.75 ± 4.09	1.75 ± 4.38

A STUDY OF VARIABILITY AND THE POSSIBILITY OF ISOLATING APOSTOL RICE STRAINS WITH STRONG RACHILLAE [1] [2]

VICTORIANO GAGOLINAN

WITH ONE TEXT FIGURE

One of the leading varieties of rice (*Oryza sativa* L.) in the Philippines is Apostol, or Inapostol. It ranks with Elon-elon, one of the first class rices, in yield and cooking quality. It is one of the rare varieties which can be raised under both upland and lowland conditions. Although Apostol possesses superior qualities in trade, from the cultural standpoint it has an agronomic defect. This defect is the occurrence of weak panicle branches (rachillae) when the crop approaches maturity or harvesting period (see fig. 1). Prior to or during the maturity stage some rachillae of the panicles break which necessitates the harvesting of the rice heads, although the grains in the whole panicle are not fully and uniformly ripe. The isolation ofApostol strains free from weak rachillae and observations on the frequency of the agronomic defect in their immediate progeny may prove valuable in breeding work and ultimately in general rice farming. Selection and testing of Apostol plants with strong rachillae may, therefore, be considered one of the steps towards the improvement of the variety. The present experiments were planned with this end in view.

The specific objects were: (*a*) to study variability of strong and weak panicle branches (rachillae) in Apostol rice variety; and (*b*) to isolate strains which have strong rachillae.

The work was carried in the Experiment Station rice fields and in the Plant Breeding Laboratory, Department of Agronomy from October, 1932 to February, 1934.

In the Philippines and other rice growing countries selection and test studies have been made on rice varieties which show variation of position of rice stalks in the field, breaking strength of culms, shattering qualities of grains in rice panicles and the laxity and bending nature of panicles. Among these studies are: Labrador, 1920: Ramiah and Dharmalingam, 1933; and Takezaki, 1932.

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[1] Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 479; Experiment Station contribution No. 1081. Prepared in the Department of Agronomy under the direction of Dr. J. M. Capinpin and Mr. Vicente B. Aragon.

[2] Rachillae found unbroken in the field are *strong* rachillae; rachillae found broken are *weak* rachillae.

Apparently, the nature of rachillae in a panicle of rice, like Apostol, has not been noted in other rice varieties so has not been studied or reported, elsewhere. Among other cereals, however, the panicle of oats showed variation which may be considered more or less related to the peculiar nature of the Apostol panicle. De Vries (1919) cited the oat-breeding work at Svalof, where it was shown that some forms of oats have a panicle with firm principal axis and erect branches and others have a panicle in which the axis is weak and the branches droop. It has also been discovered that erect and strong branches of the panicle in a variety indicate a good yielder, and weak and drooping branches a poor yielder.

MATERIALS AND METHODS

Initial selection of Apostol rice

The initial selection of plants with strong rachillae and plants with weak rachillae was made in the upland stock culture of the Farm Crops Division in the Experiment Station field of the Department of Agronomy in November, 1932. The material was selected at random from a rice field covering an area of about one-half hectare. All the bearing culms from each individual hill were harvested, bundled, and placed in a separate paper bag. The selected plants were then taken to the Plant Breeding Laboratory for detailed study. The panicles were dried gradually for some time by putting the paper bags with their contents in the sunlight.

Individual study of groups of plants

The number of plants with weak rachillae from the upland and from the lowland fields for two seasons of planting was recorded. Each panicle was weighed on a Cenco balance. The length of the panicle was measured from the last node of the culm up to the tip of the panicle. The length and weight of weak rachillae were taken. The total number of grains of breaking rachillae and the total number of grains in a panicle were counted.

Classifying sources of seed material

The rice panicles were grouped into four classes as sources of seed material: (*a*) Grains of purely strong rachillae. All panicles in a hill the rachillae of which do not break were grouped under the purely strong rachillae. (*b*) Grains from strong panicles of plants with weak rachillae. These are panicles the rachillae of which do not break, and are derived from a hill with one or two panicles the rachillae of which are weak. (*c*) Grains which are remnants of weak rachillae in a panicle. These are rachillae left after the weak rachillae in the panicle are removed. And (*d*) grains from purely weak rachillae. All the grains of the rachillae, either the lateral or central axis of which is weak, were removed and grouped. Each group was threshed and the grain put in separate paper bags and properly labelled.

Culture of seeds from plants with strong and with weak rachillae

Upland culture. Two plantings under this condition were studied. The first culture, broadcast on June 15, 1932, was the stock culture of Farm Crops Division on which initial selection of plants with strong and weak rachillae had been made. The second culture represented the experimental lots comprising the two different kinds of seed material. In this culture, the seeds were sown in furrows made by the *lithao,* a small harrow. In both cultures the land was plowed and harrowed three times before sowing.

Lowland culture. Under this condition of planting, the ordinary procedure of seed bed, paddy and dikes was followed. Two sets of planting were made and studied. In both, the seeds were from plants with strong rachillae and also from those with weak. The first transplanting was done on October 8, 1932 and the second on October 9, 1933.

Observation on heading

Observations on heading were begun at the time the heads began to shoot. Some notes were taken on the following: (*a*) at which stage the breaking of rachillae begins; (*b*) the nature of the panicle; and (*c*) where the central or lateral axis of the panicle was breaking.

Variability of weak and of strong rachillae in a given lot

The total number of plants in each lot and the number of plants that showed weak rachillae under both upland and lowland cultures were recorded. These records furnished the data on the incidence of this character under field conditions.

Pests or diseases on rice plants with strong or weak panicles

The only insect that was observed on the crop was the rice bug *Leptocorisa acuta* Thumb. The damage done by this insect was negligible. No diseases were observed that caused the breaking of rachillae. A close examination of the breaking panicles revealed no indication of its being due to fungus or insect attack.

Morphological characteristics indicative of strong and weak rachillae

Close observation was made from booting stage until maturity of the crop as to morphological characteristics of the rice plants which might serve to show that the plants have the tendency to bear or produce weak or breaking rachillae.

EXPERIMENTS AND RESULTS

Table 1 shows the number of days, counting from sowing, required under upland and lowland conditions for the Apostol rice crop plant to mature. The 1932-1933 cultures originated from the seed stock of Farm Crops. The 1933-1934 cultures were the experimental lots planted by the writer to different groups of seed selected the previous season.

Table 2 shows the occurrence of weak or breaking rachillae on the principal and secondary bearing culms observed in two cultures. The principal bearing culm was judged by the size of the panicle, its maturity, location in the rice stool, and the height of the culm. In the preliminary observations it was found that the principal bearing culm is taller, longer, earlier to mature than the secondary culms and is almost always surrounded by tillers of these culms.

The relative frequency of strong and weak rachillae under upland and lowland cultures of the two seasons of planting is shown in table 3. In order to reduce them to a basis for comparison, the relative frequency of strong and weak rachillae was expressed in percentage. The data were taken by counting the number of plants with strong and with weak rachillae which occurred in experimental lots where the total number of plants planted were known.

The relative occurrence of breaking and strong rachillae in a stool of rice was studied in the stock culture and in the progeny of the different groups of seed material. The results are summarized in table 4.

Table 5a is a summary of the 12 coefficients of correlation for six pairs of characters compared from the first planting.

Table 5b is a summary of 60 correlation tables the results of which were obtained in the second planting.

DISCUSSION OF RESULTS

Field observations

Observations were made on the stock culture and the five kinds of seeds, such as grains with strong rachillae, grains with strong rachillae from plants with weak rachillae, unselected grains, grains from remnants of weak rachillae and grains from purely weak rachillae with regard to rate of germination, uniformity, and vigor of growth. It was interesting to note that grains from strong rachillae showed the earliest sign of germination. Next to this was the group of grains with strong rachillae from plants with weak rachillae. This condition was found to be true also in the upland culture.

It was also noted that grains from strong rachillae developed into vigorous seedlings with uniform growth. Comparing the upland and the lowland seedlings, in general, the upland had a better stand than the lowland. This difference may be accounted for by difference in rainfall and delayed planting.

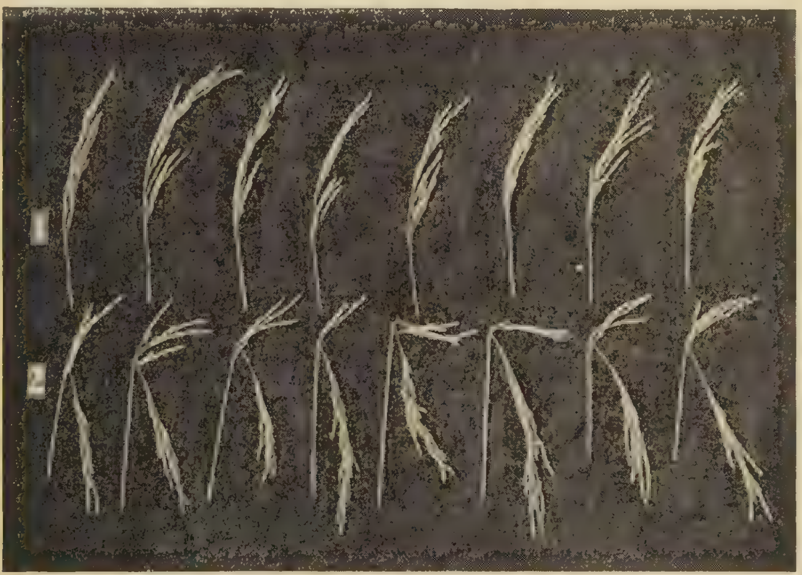

Fig. 1.—(1) Showing the panicles with strong rachillae.
(2) Showing the panicles with weak rachillae.

The weak rachillae under the two sets of conditions was noted a week before harvest. On close examination, it was found that the central axis of the panicle breaks near the second node from the base of the panicle (see fig. 1). The bending rachillae exists because the grains at the central axis were denser and heavier than those in the lateral axis. The relationship of density and weight of grains in breaking rachillae was later statistically verified.

In order to eliminate as much as possible the breaking of the rachillae by birds alighting on the plants, scarecrows were put up two or three weeks before the maturity period to scare away the birds. The panicles that showed indication by the presence of broken or empty grains in the panicle that birds might have alighted on them and fed on grains were eliminated.

Variation in maturity of Apostol under two sets of planting

The plants showed variation in maturity. In the stock culture (see table 1) the plants under upland condition matured in 152 days and in 150 days under lowland culture.

The different lots also showed slight but interesting variation in maturity periods. The upland crop of the experimental lots showed a range of maturity periods of from 158 to 165 days, with an average of 161 days. The lowland crop, on the other hand, had a range of from 144 to 150 days giving an average of 147.4 days. In both seasons of planting, the plants of grains from purely strong rachillae matured later than those of grains from purely weak rachillae.

Variation in the occurrence of breaking rachillae on the principal and secondary culms

In the stock culture, as shown in table 2, out of 70 plants studied, there were 51 principal culms with weak rachillae and 71 secondary culms under lowland culture exhibiting weak rachillae. There were 49 principal culms and 64 secondary culms out of 81 plants also under lowland.

With regard to the kinds of seed planted, out of 12 hills studied in grains of purely strong rachillae there were 8 principal culms and 9 secondary culms with weak rachillae under upland culture. Of the 11 hills under lowland culture there were 7 principal and 15 secondary culms with weak rachillae. In the study of progeny of grains from strong rachillae from plants with weak rachillae, out of 15 stools there were 12 principal and 6 secondary culms with weak rachillae under upland culture; and under lowland culture out of 16 stools 8 principal and 20 secondary culms showed weak rachillae. In the control lot out of 38 stools, 22 principal and 48 secondary culms had weak rachillae under upland culture; and out of 27 hills under lowland condition there were 17 principal and 27 secondary culms weak. The progeny of grains of remnants of weak rachillae showed a distribution of 22 principal culms and 49 secondary culms with weak rachillae out of 40 hills studied under upland condition; and in the lowland culture, out of 28 hills observed, 15 principal and 32 secondary culms had weak rachillae. The progeny of grains of purely weak rachillae showed that under upland condition out of 44 hills there were 31 principal and 44 secondary culms with weak rachillae.

And of the lowland culture out of 36 stools studied there were 24 principal and 35 secondary culms with weak rachillae. It would appear from the foregoing data that the existence of weak rachillae was in greater frequency in the secondary culms than in the principal culms. As to sources of seed or material used, the number of weak rachillae in the secondary culms exceeded those of the principal culms. A very interesting point in this connection is that the secondary culms invariably showed weak rachillae whether the materials studied had been harvested from the upland or the lowland crop.

Variation and selection for strong rachillae in two conditions of planting

In the stock culture (see table 3) under lowland culture, out of 1033 plants planted, there were 952 hills or 92.16 per cent of plants with strong rachillae and 81 hills or 7.84 per cent with weak rachillae. The grains which were classified into four different groups showed that the percentage of panicles with strong rachillae varied from 96.07 to 98.95 per cent; and the panicles with weak rachillae varied from 1.05 to 3.93 per cent. Under upland culture, the percentage of strong rachillae varied from 94.26 to 98.57, and the panicle that showed weak rachillae varied from 1.43 to 5.74 per cent. Again, in table 3 it was shown that grains with strong rachillae showed a higher percentage of plants with strong rachillae and a lower percentage of weak rachillae than the progeny of grains with purely weak rachillae. This was found to be true under the two conditions of planting. It was observed under upland culture, in the kinds of seeds planted, that grains from purely strong rachillae were 1.43 per cent lower than the progeny of unselected grains which was 4.87 per cent and much lower than the progeny of grains from purely weak rachillae which was 5.74 per cent. Under lowland planting the grains with purely strong rachillae had 1.05 per cent weak which was 2.88 per cent lower than the progeny of unselected grains and much lower than the progeny of grains of purely weak rachillae which was 3.93 per cent. The results clearly show the benefits that might accrue from selection of grains free from weak rachillae. Grains from strong rachillae gave a minimum percentage of 1.43 upland culture and 1.05 lowland culture of plants with weak rachillae. Grains from weak rachillae gave a maximum percentage of 5.74 upland culture and 3.93 lowland culture of plants with weak rachillae. The unselected stock gave, under upland condition, 4.87 per cent plants and

2.28 per cent under lowland condition with weak rachillae. This was higher than from strong seed material but lower than from weak.

Since there was no indication when the plants were blooming and at the milk stages to show the appearance of strong and weak rachillae *it is recommended that selection should be made in mass or by inspection a week before harvesting.* During this period it was found that the breaking of rachillae occurred. This nature of panicle precludes the possibility of detecting plants showing weak rachillae before the blooming period. In practice, therefore, in order to avoid the occurrence of weak rachillae in the crop, even to a small extent, it is advised to save seed of Apostol intended for planting, from hills the rachillae of which are all strong.

Hill by hill distribution of strong and weak rachillae of Apostol rice

It may be seen in table 4 that in the stock culture the occurrence of strong rachillae varied from 33.33 to 90.00 per cent in the upland planting. In the case of lowland culture the range of variability of strong rachillae was from 55.60 to 93.75 per cent. The occurrence of weak rachillae varied from 10.00 to 66.67 per cent in the upland culture and 6.25 to 44.40 per cent in the lowland culture.

In the progeny of grains with purely strong rachillae, the occurrence of panicles with strong rachillae varied from 75.00 to 94.74 per cent under upland condition, and 66.67 to 93.33 per cent under lowland. The panicles with weak rachillae varied from 5.26 to 25.00 per cent under upland culture and 6.67 to 33.33 per cent under lowland.

It is shown also in table 4 that in the progeny of grains from strong rachillae isolated from panicles bearing weak rachillae the panicles with strong rachillae varied from 66.67 to 96.00 per cent under upland condition. Under lowland condition, the percentages of panicles with strong rachillae varied from 62.50 to 90.91 per cent. The occurrence of weak rachillae varied from 4.00 to 33.33 per cent under upland condition and 9.09 to 37.50 per cent under lowland. *These data clearly indicate that the range of distribution of weak rachillae was greater in the upland culture than in lowland culture.*

The unselected stock varied from 50.00 to 94.74 per cent and 66.67 to 92.31 per cent of panicles with strong rachillae under upland and lowland conditions, respectively. For the panicles with weak rachillae the variation was from 5.26 to 50.00 per cent for upland culture and 7.69 to 33.33 per cent for lowland.

The panicles with strong rachillae varied from 35.29 to 95.65 per cent in the progeny of grains from remnants of weak rachillae under upland condition and 60.00 to 93.75 per cent under lowland culture. The panicles with weak rachillae varied from 4.35 to 64.71 per cent under upland condition and 6.25 to 40.00 per cent under lowland.

In the progeny of grains with purely weak rachillae, the occurrence of panicles with strong rachillae varied from 50.00 to 93.75 per cent under upland culture and 66.67 to 92.86 per cent under lowland. The variability of weak rachillae was from 6.25 to 50.00 per cent for upland culture and 7.14 to 33.33 per cent for lowland.

From the data given above it may be concluded that the variation and occurrence of weak rachillae from the progeny of grains with strong rachillae were relatively small and showed fewer weak rachillae than the progeny of grain with weak rachillae. This again stresses the importance of selection of seed material from plants free from breaking rachillae.

Characters correlated with nature of rachillae

First planting 1932-1933. In table 5a it may be seen that the number of panicles with strong rachillae was associated with the number of bearing culms, the coefficients of correlation for this pair of characters under upland and lowland conditions amounting to 0.712 ± 0.039 and 0.979 ± 0.009, respectively. *This would mean that rice stools with greater number of bearing culms have panicles with strong rachillae.*

In the same table it may be seen that there was a low and indifferent correlation between the number of bearing culms and number of panicles with weak rachillae. Their coefficients of correlation were 0.410 ± 0.067 under upland condition and 0.095 ± 0.007 under lowland. *This relationship shows that there is a moderate correlation in the upland culture but none whatsoever in the lowland.*

When the weight of panicles and the weight of weak rachillae were correlated the coefficients of correlation were 0.584 ± 0.053 under upland condition and 0.121 ± 0.073 under lowland. *From these data it may be concluded that there is a positive correlation between the weight of weak rachillae and weight of panicles.* These coefficients, however, are marked under upland culture but are relatively low under lowland.

There was a high correlation between length of panicles and length of breaking rachillae. The coefficient of correlation under upland condition was 0.667 ± 0.034 and under lowland, 0.705 ±

0.031. The relationship between the length of panicles and the length of weak rachillae under upland and lowland conditions was marked.

When the length of weak rachillae was correlated with the number of grains of weak rachillae, it was found that the coefficient of correlation was 0.360 ± 0.053 for upland condition and 0.705 ± 0.031 for lowland. The correlation coefficients were moderate under upland condition and high under lowland culture.

When the number of grains in a panicle and the number of grains in a weak rachillae were correlated the coefficients of correlation found were 0.879 ± 0.013 for upland culture and 0.663 ± 0.035 for lowland. *Under the two sets of conditions it may be noted that there was a decidedly high correlation between the number of grains in a panicle and the number of grains in weak rachillae.*

It will be noted from the foregoing paragraphs that the correlated characters were all characters of Apostol rice which may be utilized in the selection of plants with either strong or weak rachillae. In all cases the existence of a high correlation between the number of bearing culms and the number of panicles with strong rachillae is definitely established. From the practical viewpoint this relation may be helpful in selection, for plants with more bearing culms have the greater number of strong rachillae.

Second planting 1933-1934. The coefficients of correlation for 1933-1934 are shown in table 5b. Besides the correlation shown in 5a, table 5b also shows that some definite result with regard to the isolation of panicles with strong rachillae can be obtained. Under upland condition in the progeny of grains with strong rachillae the correlation between number of bearing culms and number of panicles with weak rachillae was -0.004 ± 0.194, which shows that there was no correlation at all, the correlation, if any, tending to be negative. The coefficients of correlation of the progeny of grains with purely weak rachillae under the same condition was 0.492 ± 0.077, which means a moderate correlation.

Under lowland condition, the progeny of grains from strong rachillae has 0.244 ± 0.191 coefficients of correlation between number of bearing culms and number of panicles with weak rachillae. Under the same condition the progeny of grains with weak rachillae gave 0.454 ± 0.089 coefficients of correlation. From these data it will be seen that *there is a slight correlation between number of bearing culms and number of panicles with weak rachillae in the progeny of grains from strong rachillae.* The progeny of grains with weak rachillae showed moderate correlation under lowland condition.

In table 5b when the coefficient of correlation between the number of bearing culms and the number of panicles with weak rachillae of the progeny of grains with strong rachillae is compared with the coefficients of correlation of the progeny of the unselected grains, it may be seen that the coefficients of correlation of the progeny of grains with strong rachillae is –0.004 ± 0.194 which means negative but insignificant correlation; that of the progeny of unselected grains was 0.312 ± 0.098 which meant moderate correlation under upland condition. Under the lowland condition the progeny of grains of purely strong rachillae gave 0.244 ± 0.191 coefficient of correlation between number of bearing culms and number of panicles with weak rachillae. The progeny of grains of the unselected stock gave 0.588 ± 0.083 coefficient or correlation between number of bearing culms and number of panicles. From the foregoing data it can be seen that *there is a low correlation between number of bearing culms and number of panicles with weak rachillae in the progeny of grains with strong rachillae and a high coefficient of correlation in the progeny of the unselected grains under lowland condition.* Therefore, it can be concluded that grains of purely strong rachillae are much better than the grains of weak rachillae of the unselected stock. The grains of purely strong rachillae produced few weak rachillae, while the progeny of grains of unselected plants produced many weak rachillae. Hence, grains with strong rachillae are recommended for planting so as to keep the field clean of panicles with weak rachillae.

SUMMARY AND CONCLUSIONS

A summary of results obtained is here given:

1. In the first planting the plants matured in 152 days under upland culture and in 150 days under lowland culture; and in the second planting, the five kinds of seeds had an average period of maturity of 161 days under upland culture and 147.4 days under lowland.

2. In the material obtained from the stock culture there were more secondary culms than principal that were weak under both upland and lowland culture. Of the five groups of seed obtained there were 95 principal and 156 secondary culms under upland condition and 71 principal and 129 secondary culms breaking.

3. The lowest percentage of weak rachillae was observed in lots planted to grains from purely strong rachillae, while the highest percentage of weak rachillae was found in lots planted to grains from purely weak rachillae. The progeny of grains from purely strong rachillae gave 1.43 per cent weak rachillae in the upland culture, and 1.05 per cent in the lowland. The progeny of grains from

purely weak rachillae gave 5.74 per cent weak rachillae in the upland planting, and 3.93 per cent in the lowland. The unselected stock gave 4.8 per cent weak rachillae in upland culture and 1.63 per cent in the lowland.

4. The percentage of weak rachillae in plants based on the number of panicles or bearing culms varied from 4 to 66.60 per cent in upland culture and from 6.25 to 44.40 per cent in lowland.

5. The number of panicles with strong rachillae was decidedly correlated with the number of bearing culms. The more bearing culms the plant produced the greater number of strong rachillae.

6. There were decidedly positive correlations between the length of panicles and length of weak rachillae and the number of grains in a panicle and the number of grains of breaking rachillae.

7. The coefficient of correlation between the number of bearing culms and the number of panicles with weak rachillae in the progeny of grains of purely strong rachillae was –0.004 ± 0.194 under upland condition, and 0.244 ± 0.191 under lowland. The coefficients of correlation for this same pair of characters in the progeny of grains of purely weak rachillae were 0.492 ± 0.077 under upland condition and 0.454 ± 0.089 under lowland.

8. The weight of weak rachillae with grains was associated with the weight of panicles. The correlation was either slightly or highly positive.

9. There were moderate and decided correlations between the length of weak rachillae and number of grains of weak rachillae and between the number of grains in a panicle and the number of grains of weak rachillae.

10. The test showed that Apostol rice panicles, mass selected for freedom from weak rachillae, produced in the second planting a considerably lower percentage of plants with weak rachillae. Unselected seeds gave the higher percentage of weak rachillae.

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TABLE 1

Showing maturity period of Apostol rice under upland and lowland conditions

KINDS OF SEED PLANTED	UPLAND CONDITION			LOWLAND CONDITION			
	Date		Days to maturity	Date			Days to maturity
	planted	harvested		planted	transplanted	harvested	
Stock Culture	VI-15, 16-32	XI-14-32	152	VIII-19-32	X-8-32	I-15-33	150
Grains of purely strong rachillae	VI-1-33	XI-12-33	165	VIII-9-33	X-9-33	I-2-34	150
Grains of strong rachillae from plants with weak	VI-1-33	XI-10-33	163	VIII-9-33	X-9-33	I-1-34	149
Control or unselected grains	VI-1-33	XI-8-33	161	VIII-9-33	X-9-33	XII-31-33	148
Grains of remnants of weak rachillae	VI-1-33	XI-5-33	158	VIII-9-33	X-9-33	XII-29-33	146
Grains of purely weak rachillae	VI-1-33	XI-5-33	158	VIII-9-33	X-9-33	XII-27-33	144
Averages of the five kinds of seeds planted			161				147.4

TABLE 2

Showing the frequency of weak rachillae on the principal and secondary bearing culms in two cultures

KINDS OF SEED PLANTED	UPLAND CONDITION			LOWLAND CONDITION		
	Number of hills studied [a]	Number of		Number of hills studied [a]	Number of	
		principal culms	secondary culms		principal culms	secondary culms
Stock culture	70	51	71	81	49	64
Grains of purely strong rachillae	12	8	9	11	7	15
Grains of strong rachillae from plants with weak rachillae	15	12	6	16	8	20
Control or unselected	38	22	48	27	17	27
Grains of remnants of weak rachillae	40	22	49	28	15	32
Grains of purely weak rachillae	44	31	44	36	24	35
Total of five kinds of seeds	149	95	156	118	71	129

[a] Actual number of stools found in the experimental culture with weak rachillae.

TABLE 3

Showing the relative frequency of strong and weak rachillae and seed stock from selected plants under upland and lowland conditions

KINDS OF SEED PLANTED	UPLAND CONDITION			LOWLAND CONDITION		
	Total plants planted	Plants with strong rachillae	Plants with weak rachillae	Total plants planted	Plants with strong rachillae	Plants with weak rachillae
Stock culture	Farm[a] Crops	50	70	1033	952 (92.16%)	81 (7.84%)
Grains of purely strong rachillae	840	828 (98.57%)	12 (1.43%)	1048	1037 (98.95)	11 (1.65)
Grains of strong rachillae from plants with weak rachillae	868	853 (98.27)	15 (1.73)	983	967 (98.37)	16 (1.63)
Control or unselected	780	742 (95.13)	38 (4.87)	937	910 (97.12)	27 (2.88)
Grains of remnants of weak rachillae	768	728 (94.79)	40 (5.21)	923	895 (96.97)	28 (3.03)
Grains of purely weak rachillae	767	723 (94.26)	44 (5.74)	917	881 (96.07)	36 (3.93)

[a] Not determined, but 50 plants with strong rachillae and 70 plants with weak rachillae were selected at random for material.

TABLE 4

Showing the occurrence of strong and of weak rachillae in one panicle to a stool of Apostol rice under field conditions

KINDS OF SEED MATERIAL	UPLAND				LOWLAND			
	Panicle with strong rachillae		Panicle with weak rachillae		Panicle with strong rachillae		Panicle with weak rachillae	
	maximum per cent	*minimum per cent*	*maximum per cent*	*minimum per cent*	*maximum per cent*	*minimum per cent*	*maximum per cent*	*minimum per cent*
Stock culture	90.00	33.33	66.66	10.00	93.75	55.60	44.40	6.25
Progeny of purely strong	94.74	75.00	25.00	5.26	93.33	66.67	33.33	6.67
Progeny of strong from weak	96.00	66.67	33.33	4.00	90.91	62.50	37.50	9.09
Unselected stock	94.74	50.00	50.00	5.26	92.31	66.67	33.33	7.61
Progeny of remnants from weak	95.65	35.29	64.71	4.35	93.75	60.00	40.00	6.25
Progeny of purely weak	93.75	50.00	50.00	6.25	92.86	66.67	33.33	7.14

TABLE 5a[a]

Showing the coefficients of correlation of characters of Apostol rice of two cultures of 1932-1933

CHARACTERS COMPARED	UPLAND RICE APOSTOL, VARIETY	LOWLAND RICE APOSTOL, VARIETY
1. Number of bearing culms and number of panicles with strong rachillae.	0.712 ± 0.039	0.979 ± 0.009
2. Number of bearing culms and and number of panicles with weak rachillae.	0.410 ± 0.067	0.095 ± 0.007
3. Weight of panicles and weight of weak rachillae.	0.584 ± 0.053	0.121 ± 0.073
4. Length of panicles and length of weak rachillae.	0.667 ± 0.034	0.705 ± 0.031
5. Length of weak rachillae in centimeters and number of grains in weak rachillae.	0.360 ± 0.053	0.705 ± 0.031
6. Number of grains in a panicle and number of grains in weak rachillae.	0.879 ± 0.013	0.663 ± 0.035

[a] Summary of the 12 correlation tables, which are not included in this report, but are filed in the Agronomy Department, College of Agriculture.

TABLE 5b[a]

Showing the coefficients of correlation of characters of Apostol rice of two cultures of 1933-1934[a]

CHARACTERS COMPARED	UPLAND RICE APOSTOL VARIETY				
	Grains of purely strong rachillae	Grains of strong rachillae from plants with weak rachillae	Control or unselected	Grains of remnants of weak rachillae	Grains of purely weak rachillae
1. Number of bearing culms and number of panicles with strong rachillae.	0.995 ± 0.002	0.970 ± 0.092	0.965 ± 0.008	0.871 ± 0.025	0.813 ± 0.035
2. Number of bearing culms and number of panicles with weak rachillae.	—0.004 ± 0.194	0.129 ± 0.175	0.312 ± 0.098	0.255 ± 0.041	0.492 ± 0.077
3. Weight of panicles and weight of weak rachillae.	0.013 ± 0.194	0.282 ± 0.163	0.532 ± 0.078	0.387 ± 0.091	0.410 ± 0.084
4. Length of panicle and length of weak rachillae.	0.902 ± 0.030	0.325 ± 0.142	0.682 ± 0.043	0.728 ± 0.038	0.654 ± 0.045
5. Length of weak rachillae and number of grains of weak rachillae.	0.322 ± 0.146	0.483 ± 0.122	0.741 ± 0.036	0.489 ± 0.061	0.870 ± 0.019
6. Number of grains in a panicle and number of grains of weak rachillae.	0.920 ± 0.024	0.870 ± 0.038	0.820 ± 0.026	0.830 ± 0.029	0.940 ± 0.009

[a] Summary of the 60 correlation tables, which are not included in this report, but are filed in the Agronomy Department, College of Agriculture.

TABLE 5b (Continued)

CHARACTERS COMPARED	LOWLAND RICE APOSTOL VARIETY				
	Grains of purely strong rachillae	Grains of strong rachillae from plants with weak rachillae	Control or unselected grains	Grains of remnants of weak rachillae	Grains of purely weak rachillae
1. Number of bearing culms and number of panicles with strong rachillae.	0.679 ± 0.107	0.881 ± 0.038	0.954 ± 0.013	0.934 ± 0.017	0.967 ± 0.008
2. Number of bearing culms and number of panicles with weak rachillae.	0.244 ± 0.191	0.202 ± 0.162	0.588 ± 0.083	0.330 ± 0.114	0.454 ± 0.089
3. Weight of panicles and weight of weak rachillae.	0.233 ± 0.192	0.163 ± 0.164	0.709 ± 0.064	0.495 ± 0.096	0.505 ± 0.083
4. Length of panicle and length of weak rachillae.	0.927 ± 0.021	0.631 ± 0.077	0.814 ± 0.034	0.746 ± 0.044	0.870 ± 0.021
5. Length of weak rachillae and number of grains of weak rachillae.	0.581 ± 0.095	0.511 ± 0.091	0.422 ± 0.083	0.320 ± 0.087	0.533 ± 0.037
6. Number of grains in a panicle and number of grains of weak rachillae.	0.461 ± 0.113	0.768 ± 0.051	0.671 ± 0.056	0.793 ± 0.037	0.665 ± 0.048

A STUDY OF THE N-P_2O_5-K_2O RATIO FOR AN UPLAND RICE (ORYZA SATIVA L. VAR ININTIW) WHEN GROWN IN TUFF SOIL IN POTS[1]

MARIANO S. MACASAET

WITH FIVE TEXT FIGURES

It is desirable that the N-P-K (or the N-$P_2O_5K_2O$) requirements of rice plants be determined. But, no culture solution has as yet been found that could bring the rice plant to complete maturity. Espino (1920) and Espino and Estioko (1931) succeeded in growing rice plant normally for the first thirty or forty days in certain culture solutions. Beyond this stage of development, however, the plant always produced chlorotic young leaves. In fact, the youngest visible leaf, which was still rolled, not only came out decidedly chlorotic but soon became dry[2].

Fertilizer culture tests with young coconut (Valenoba, 1935) and lanzon (Mariano, 1934) plants made in pots in the Laboratory of Plant Physiology of this College showed that tuff soil, (the typical subsoil of the Lipa clay loam) serves as an excellent solid medium for fertilizer tests. So, it was decided to employ tuff soil as the solid medium in the present study, especially as the N-P_2O_5-K_2O contents of this soil[3] had been recently determined at this College.

Preliminary culture trials showed that some of the cultures that were fertilized with sulfate of ammonia produced rice plants normally developed in every respect. For this reason, it can be said that the use of the two commercial fertilizers, ammonium sulfate and superphosphate, in the present study seems to be fully justified. It can also be said that from the results of the present study, it appears quite possible to determine N-P_2O_5-K_2O ratio of the rice plant, variety Inintiw when grown in tuff soil in pots.

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[1] Thesis presented for graduation, 1935, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 480; Experiment Station contribution No. 1082. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

[2] Mr. F. de Peralta, formerly of the Department of Plant Physiology of the College of Agriculture, worked on this problem, though not continuously, for about two years, but with no satisfactory results.

[3] The soil used was taken from the same place that Valenoba (1935) obtained the soil he used. He found the soil to contain 0.14 per cent N; 0.48 per cent P_2O_5 and 0.50 per cent K_2O.

REVIEW OF LITERATURE

Using ordinary garden soil, Vibar (1926) found that 70 grams of ammonium sulfate per culture gave the highest yield of straw and of grain in an upland rice. But, when the rate of application was increased there was a decrease in yield. On sandy soil, Chan (1929) observed that the application of 100, 120, 200, and 300 pounds of sulfate of ammonia per acre (or 112.26; 134.71; 224.55; and 336.81 kgm. per ha.) increased the yield of rice. He noted, however, that the increase was not proportional to the increase of the cost of the fertilizer used. Chan found that an application of 200 pounds per acre (or 224.55 kgm. per ha.) gave the highest yield of grain.

At Biggs Rice Station, Jones (1931) found that 150 pounds sulfate of ammonia per acre, (or 168.40 kgm. per ha.) gave the most profitable yield of rice. Reynolds and Wyche (1929) observed, however, that 100 pounds ammonium sulfate to the acre (or 112.26 kgm. per ha.) produced rice grain most profitably, although they also found that the yield of rice increased as the rate of application of the fertilizer was increased. The rate of increase, however, was not proportional to the amount of fertilizer applied. Kaff (1933) reported that the yield of rice grain increased as much as 116 per cent when 243 pounds of sulfate of ammonia per acre (or 272.69 kgm. per ha.) were added to the soil. In 1914, Kelley also found that the application of 150 pounds per acre of ammonium sulfate (or 168.40 kgm. per ha.) produced a notable increase in the yield, but 300 pounds per acre (or 336.81 kgm. per ha.) proved more profitable. Chambliss (1920) noted that the yield of rice was greatly increased by the application of ammonium sulfate at the rate of 70 pounds per acre (or 78.60 kgm. per ha.).

Kelley (1911) added 70 pounds of ammonium sulfate to the acre (or 78.60 kgm. per ha.) and found that by applying the fertilizer before planting a greater yield both in straw and in grain was obtained than when the same amount of the fertilizer was used in six applications after the rice was planted.

According to Lord (1934) the application of one cwt. per acre of concentrated superphosphate to rice paddies gave an increase in the yield of rice. Jones (1931) reported that in Biggs Rice Station the application of non-nitrogenous fertilizers failed to increase rice yield. But when 331 pounds superphosphate per acre (or 371.49 kgm. per ha.) were added to a field which had been lying fallow for two years, Nelson (1931) observed a decrease in the yield of rice.

The fertilized plot gave an average yield of 1,333 pounds of grain; while the control produced a little more, 1,848 pounds of grain.

Kaff (1933) observed that the beneficial effects of nitrogen was not carried over to the second crop, as the yields of grain and straw were about the same in the fertilized plots and the control. The residual effects on the fall crop from the spring application of the ammonium sulfate were very small (Kelley, 1914). Kelley (1911) and Kaff (1933) suggest that nitrogenous fertilizers should be applied before seeding. Kelley and Thompson (1910) found that the rice plant by the time it is two-thirds grown has normally taken up about four-fifths of its maximum nitrogen and phosphoric acid and nine-tenths of the potash needed.

It may thus be seen from this review of available literature that although several fertilizer tests have been made with the rice plant, in which ammonium sulfate, superphosphate, or both fertilizers were added to the soil, no report was found of an attempt to determine the $N-P_2O_5-K_2O$ requirements of the plant.

OBJECTS, TIME AND PLACE OF THE PRESENT WORK

This study was carried out with the objects of determining (*a*) the $N-P_2O_5-K_2O$ ratio of an upland rice when grown in tuff soil in pots, and (*b*) to determine the residual effects of the commercial fertilizers, ammonium sulfate and superphosphate added to tuff soil in pots, when the culture media are once more grown to rice. It might be considered as the third object of this study the finding out whether or not the rice plant can be grown successfully and normally in tuff soil, (the subsoil of the Lipa clay loam) if the only supply of K or K_2O to the plant is that found in the soil.

The experiments reported in this paper were conducted in the experimental lot of the Department of Plant Physiology, College of Agriculture, at Los Baños, Laguna, from April, 1933 to October, 1934.

MATERIAL AND METHODS

The solid culture media

Tuff soil, otherwise known as the subsoil of the Lipa clay loam soil was used as the solid medium in this study. For chemical analysis of soil, see footnote 3. The soil was taken from the land at the rear of the Plant Physiology building. It was pulverized, air dried, mixed thoroughly and sifted.

Sixty-four kerosene cans with holes in the bottom for drainage were used as pots in each set of cultures. Each pot contained 19 kilograms of the air-dry soil.

The plant

Seed of an upland rice, *Oryza sativa* L. variety Inintiw obtained locally was used in this study. The seed was soaked in water for twenty-four hours. Four to six of the soaked seeds were planted in each pot. Almost one hundred per cent germination was obtained. When the young plants were about one week old, all but two of the most uniformly developed and healthy seedlings were pulled up.

Fertilizers used

Ammonium sulfate containing 20.6 per cent N, and superphosphate containing 18 to 20 per cent P_2O_5, (in the computation, 20 per cent was used) separately or in certain amounts and combinations, were added to the cultures, as shown in the following tabulation. In this tabulation are also shown the N and P_2O_5 contents of the fertilizers, and the N-P_2O_5-K_2O contents of the fertilizers and the soil:

Tabulation 1

CULTURE NO.	SULFATE OF AMMONIA	SUPERPHOSPHATE	FROM THE FERTILIZER		FROM THE SOIL AND FERTILIZER		
			N	P_2O_5	N	P_2O_5	K_2O
	grams	*grams*	*gram*	*gram*	*grams*	*grams*	*grams*
I	4.83	—	0.99	—	27.59	91.20	95.00
II	4.14	—	0.85	—	27.45	91.20	95.00
III	2.76	—	0.57	—	27.17	91.20	95.00
IV	1.38	—	0.28	—	26.88	91.20	95.00
V	0.69	—	0.14	—	26.74	91.20	95.00
VI	—	4.83	—	0.97	26.60	92.17	95.00
VII	—	4.14	—	0.83	26.60	92.03	95.00
VIII	—	2.76	—	0.55	26.60	91.75	95.00
IX	—	1.38	—	0.28	26.60	91.48	95.00
X	—	0.69	—	0.14	26.60	91.34	95.00
XI	0.69	4.83	1.14	0.97	26.74	92.17	95.00
XII	1.38	4.14	0.28	0.83	26.88	92.03	95.00
XIII	2.76	2.76	0.57	0.55	27.17	91.75	95.00
XIV	4.14	1.38	0.85	0.28	27.45	91.48	95.00
XV	4.83	0.69	0.99	0.14	27.59	91.34	95.00
XVI	Control	—	—	—	26.60	91.20	95.00

NOTE: The fertilizers were applied at the time the seeds were sown in the pots.

The rate of application to a can was computed on the basis of one hectare; 4.83 grams to a pot corresponds to 7/8 ton per hectare; 4.14 grams corresponds to 3/4 ton per hectare; 2.76 grams corresponds to 1/2 ton per hectare; 1.38 grams corresponds to 1/4 ton per hectare, and 0.69 grams corresponds to 1/8 ton per hectare.

EXPERIMENTS AND RESULTS

Types of experiments

There were two main types of experiments. One of them consisted of sets of fertilizer cultures in which the fertilizers were freshly added. In this paper this type is designated as the *initial effect* tests. The other type consisted of sets of cultures in which no new addition of fertilizers was made. The second type may be considered as cultures that were run for the purpose of determining the *residual* effects of the fertilizers.

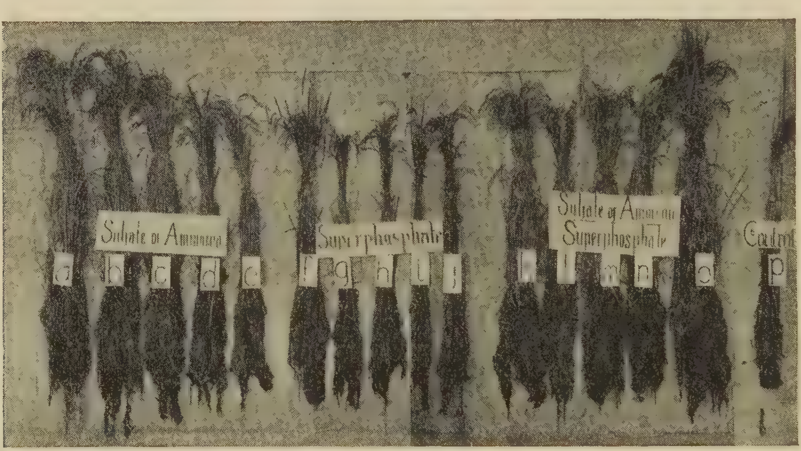

Fig. 1.—Rice plants grown in tuff soil in pots supplied with sulfate of ammonia, (left to right) *a*, 4.83 grams; *b*, 4.14 grams; *c*, 2.76 grams; *d*, 1.38 grams, and *e*, 0.69 gram. Superphosphate, *f*, 4.83 grams; *g*, 4.14 grams; *h*, 2.76 grams; *i*, 1.38 grams, and *j*, 0.69 gram. Superphosphate + sulfate of ammonia, *k*, 4.83 grams + 0.69 gram; *l*, 4.14 grams + 1.38 grams; *m*, 2.76 grams + 2.76 grams; *n*, 1.38 grams + 4.14 grams; and *o*, 0.69 gram + 4.83 grams, and *p*, control (no fertilizer). Photographed at harvest on September 2, 1933.

The cultures

Using the fertilizers in amounts and combinations as shown in the preceding tabulation, four sets of cultures were conducted. The first set was started on April 22, 1933 and harvested on September 2, 1933 (see fig. 1 and table 1). The second set, which was a repetition of the first set, was run from May 27, 1933 to September 30, 1933, the time when the cultures were harvested (see fig. 2 and table 2). The third repetition was run from November 18, 1933 to March 2, 1934 and photographed on February 20, 1934, (see fig. 3A and table 3). And the fourth repetition was run from March 17, 1934 to August 2, 1934 and photographed on July 22, 1934, (See fig. 4A and table 4). Each culture was replicated four times.

The sets of cultures for the *residual effects of the fertilizers* were tried as follows: The first set was run from September 16, 1933 to January 17, 1934 (see fig. 5 and table 5). The culture media here employed were those tested in the first set of cultures (April 22 to September 2, 1933) that determined the initial effects of the fertilizers. The second set was carried out from December 2, 1933 to March 29, 1934 and consisted of the culture media that were employed in the second set of cultures (May 27 to September 30, 1933) for the initial effects of the fertilizers (see fig. 3B (lower row) and table 6). The third set was planted on March 17, 1934 and harvested on August 2, 1934. It comprised the culture media employed as the third set of cultures (November 18, 1933 to March 2, 1934) for the initial effects of the fertilizers (see fig. 4B (lower row) and table 7). The cultures in the fourth set were destroyed by a typhoon.

Care given to the cultures

All the cultures were placed in the experimental lot of the Department of Plant Physiology, directly exposed to the sun. From time to time the cultures were weeded, cultivated and watered[4]. During the rainy season, care was taken to keep the drainage holes of each pot open so as to prevent accumulation of standing water in the pot. Frequent inspection of the plants for insect pests were made and any found were destroyed. To prevent birds from eating the grain, the panicles of rice were separately covered with paper bags.

Criteria of results

Rate of growth of the plant. Weekly growth measurements of two representative plants in each culture were taken from certain base marks to the tip of the highest leaf. The base mark was a piece of bamboo stick with flattened end driven into the soil near the base of the plant. The upper end of the base mark was level with the surface of the soil. Measuring was begun one week after planting and was continued weekly; a meter stick was used. Owing to discrepancies or variations of results, the data obtained on weekly growths are not given here. The data on average heights of the plants in the *initial effects* of the fertilizers, however, are given in tables 1 to 4 and those for the *residual effects,* in tables 5 to 7.

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[4] Tap water was used. This water as analyzed by Cruz and Marfori (1934) was found to contain 0.019 to 0.121 free NH_3, 0.089 to 2.17 NO_3, and 0.002 to 0.022 NO_2 in part per million.

Number of tillers. The tillers were counted at the time of harvest. The actual data for the *initial effects* of the fertilizers are recorded in appendix tables 1 to 4 [5], and the data on average number of tillers per culture are given in tables 1 to 4. The data on averages were obtained by adding together the number of tillers present in each quadruplicate culture, and then dividing the total by 4. The actual data for the *residual effects* of the fertilizers are given in appendix tables 5 to 7, and the data on averages, in tables 5 to 7.

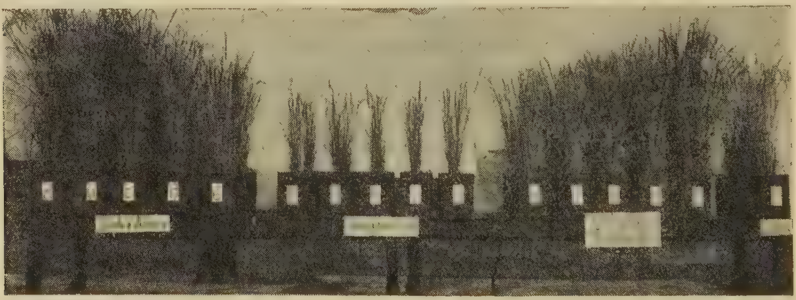

Fig. 2.—Rice plants grown in tuff soil in pots supplied with sulfate of ammonia, (left to right) *a*, 4.83 grams; *b*, 4.14 grams; *c*, 2.76 grams; *d*, 1.38 grams, and *e*, 0.69 gram. Superphosphate, *f*, 4.83 grams; *g*, 4.14 grams; *h*, 2.76 grams; *i*, 1.38 grams and *j*, 0.69 gram. Superphosphate + sulfate of ammonia, *k*, 4.83 grams + 0.69 gram; *l*, 4.14 grams + 1.38 grams; *m*, 2.76 grams + 2.76 grams; *n*, 1.38 grams + 4.14 grams; and *o*, 0.69 gram + 4.83 grams, and *p*, control (no fertilizer). Photographed on September 11, 1933 when the plants were 15 weeks old.

Air-dry weights of roots, straw and grains. In the first set of cultures all the plants were allowed to mature before they were harvested. In harvesting, the plants were carefully removed from the pots and the soil clinging on the roots was washed off with water. Then the plants from the different cultures were separately bundled together and were photographed (see fig. 1). This process was not found practicable as the plants did not mature at the same time. In the succeeding cultures, another process was followed.

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[5] All appendix tables are on file in the Department of Plant Physiology.

On reaching maturity, the grain was threshed directly from the plants, placed in paper bags and dried in the laboratory. The tops were harvested next. They were cut near the surface of the soil and then dried in the air in the laboratory. The roots were also gathered by carefully removing them from the pots and shaking off the soil particles. The little soil that did not shake off was washed off with water. Then the roots were allowed to dry in the air. The weights of the air-dried roots, straw and grain from the different cultures were separately determined. By winnowing, the empty grains were separated from the full grains.

The actual data on air-dry weight of roots of the plants in the *initial effect* tests are given in appendix tables 1 to 4, and the averages are shown in tables 1 to 4. The data on averages were obtained by adding together the air-dry weights of the roots that were obtained from each quadruplicate culture and the sum was divided by 4. The data for the *residual effects* are recorded in appendix tables 5 to 7 and the data on averages in tables 5 to 7.

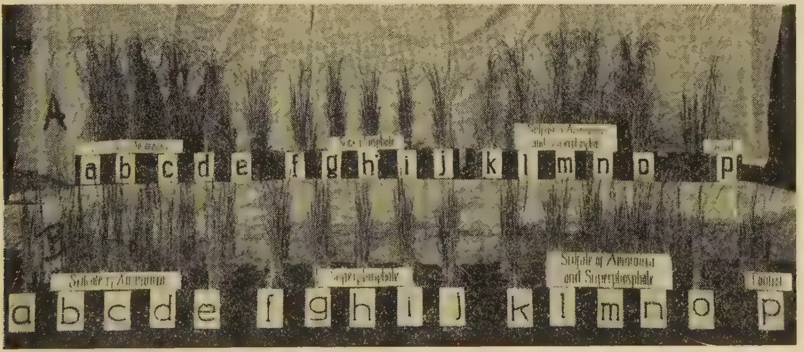

Fig. 3.—A, (upper row), rice plants grown in tuff soil in pots supplied with sulfate of ammonia, (left to right) *a*, 4.83 grams; *b*, 4.14 grams; *c*, 2.76 grams; *d*, 1.38 grams, and *e*, 0.69 gram. Superphosphate + sulfate of ammonia, *k*, 4.83 grams + 0.69 gram; *l*, 4.14 grams + 1.38 grams; *m*, 2.76 grams; + 2.76 grams; *n*, 1.38 grams + 4.14 grams; and *o*, 0.69 gram + 4.83 grams, and p, control (no fertilizer). *B*, (lower row), rice plants grown in the soil used in the second test for *initial effect* of the fertilizer. Planted on December 2, 1933, and harvested on March 29, 1934. Photographed on February 20, 1934 when the plants were 14 weeks old.

The air-dry weight of straw from each culture was then determined by weighing it on a Cenco balance. The actual data obtained from the *initial effect* tests are given in appendix tables 1 to 4, and the averages recorded in tables 1 to 4. The data on averages were obtained by adding together the air-dry weights of the straw obtained from each quadruplicate culture, and the sum was divided by 4. The data for the *residual effects* are given in appendix tables 5 to 7, and in averages, in tables 5 to 7.

The air-dry weights of full grains obtained from the different cultures were separately weighed on a "triple beam" balance. The actual data obtained from the *initial effect* tests are shown in appendix tables 1 to 4, and the data on average air-dry weights in tables 1 to 4. The average was obtained by adding together the air-dry weights of full grains from each quadruplicate culture, and then dividing the total by 4. The data obtained from the *residual effect* tests are shown in appendix tables 5 to 7, and the averages in tables 5 to 7.

The data on the air-dry weight of empty grains from the different cultures were similarly obtained and for the initial effect tests are recorded in appendix tables 1 to 4, and the data on averages in tables 1 to 4. Those for the *residual effect* tests the actual data are given in appendix tables 5 to 7, and those on averages in tables 5 to 7.

DISCUSSION OF RESULTS

Selecting the best cultures

The actual data in the appendix tables having been averaged in tables 1 to 4 for the *initial effects* of the fertilizers, an arbitrary selection of the three best results or cultures under each of the criteria of results employed, except the criterion on *empty grains*, becomes comparatively simple. Thus, the three highest values under each of the criteria on (*a*) *number of tillers*, (*b*) *height of plants*, (*c*) *air-dry weight of roots*, (*d*) *air-dry weight of straw*, and (*e*) *air-dry weight of full grains* were arbitrarily selected and indicated by H's in tables 1 to 4, inclusive.

Inspection of tables 1 to 4 reveals that the H's appear most frequently under cultures I, II, III, XIV, and XV. When the actual values under each criterion and under each culture in those four tables were added together and averaged, the following data were obtained:

Tabulation 2

CULTURE NO.	NUMBER OF TILLERS	HEIGHT OF PLANTS	AIR-DRY WEIGHT OF		
			roots	straw	full grains
		cm.	*grams*	*grams*	*grams*
I	35.6H	113.8	45.8	104.5H	48.99
II	33.7H	118.6H	61.1H	91.1H	51.97H
III	28.7	109.2	50.9	72.8	51.49H
XIV	31.3	109.2	42.5	63.2	37.03
XV	33.2	118.9H	55.3H	87.1	47.97

Now, arbitrarily selecting the two highest values under each criterion and indicating each in tabulation 2 by an H, the best culture of all may be found. It may be seen that cultures I and XV have two H's each, culture III had one H, culture II has five H's, or has one H under each of the criteria of results employed. Culture II may, therefore, be considered as the best culture of the lot under the criteria of (*a*) *number of tillers,* (*b*) *height of plants,* and (*c*) *air-dry weights of roots, straw, and full grains.*

Addition of P_2O_5 harmful to rice plants

Inspection of the data in tables 1 to 4 also shows that the cultures that were fertilized with superphosphate produced, under the criteria of results employed, results that were in most cases inferior to or lower than the corresponding results that were obtained from the control cultures. Evidently tables 1 to 4 show that the highest result under each of the criteria employed falls in most cases in culture VI. When the corresponding actual values under each criterion of results obtained from the phosphate fertilized cultures giving the highest and lowest yield were added separately and averaged, results were obtained, which, when compared with those from the control cultures, gave the following:

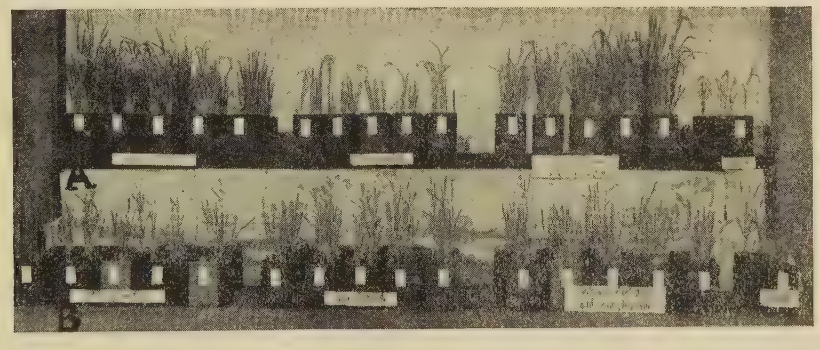

Fig. 4.—A, (upper row), rice plants grown in tuff soil in pots supplied with sulfate of ammonia, (left to right) *a*, 4.83 grams; *b*, 4.14 grams; *c*, 2.76 grams; *d*, 1.39 grams; and *c*, 0.69 gram. Superphosphate, *f*, 4.83 grams; *g*, 4.14 grams; *h*, 2.76 grams; *i*, 1.38 grams, and *j*, 0.69 gram. Superphosphate + sulfate of ammonia, *k*, 4.83 grams + 0.69 gram; *l*, 4.14 grams + 1.38 grams; *m*, 2.76 grams + 2.76 grams; *n*, 1.38 grams + 4.14 grams; and *o*, 0.69 gram + 4.83 grams, respectively, and *p* control (no fertilizer). B, (lower row), rice plants grown in the soil used in the third set for the *initial effect* of the fertilizers to the rice plants. Photographed on July 22, 1934 when the plants were 14 weeks old.

Tabulation 3

CULTURE NO.	NUMBER OF TILLERS	HEIGHT OF PLANTS	AIR-DRY WEIGHT OF roots	AIR-DRY WEIGHT OF straw	AIR-DRY WEIGHT OF full grains
		cm.	*grams*	*grams*	*grams*
VI	9.0	70.1	8.1	11.4	6.71
X	6.8	68.7	5.8	7.8	5.25
Control	10.1	77.3	9.2	14.7	8.66

To be able to show more clearly the relative fertilizing values of cultures VI, X and the control, the actual values under each criterion of results were converted into their corresponding *relative values.* The actual value for the control culture under each criterion was arbitrarily considered as 100; the other actual values were reduced relatively, according to this assumed value. The results are shown in the following tabulation:

Tabulation 4

CULTURE NO.	NUMBER OF TILLERS	HEIGHT OF PLANTS	AIR-DRY WEIGHT OF roots	AIR-DRY WEIGHT OF straw	AIR-DRY WEIGHT OF full grains
VI	89	91	88	78	77
X	67	89	63	53	61
Control ...	100 (10.1)	100 (77.3 cm.)	100 (9.2 grams)	100 (14.7 grams)	100 (8.66 grams)

It may be seen in tabulation 4 that even the best culture (culture VI) in the phosphate fertilized lot produced results, under the criteria employed, inferior to or poorer than the unfertilized cultures. Moreover, the poorest, apparently, of the phosphate fertilized cultures was far inferior to the control. Therefore, addition of superphosphate alone to tuff soil, or the subsoil of the Lipa clay loam soil can not be recommended as it proved in this study to be harmful to the rice plant. This result seems to corroborate the findings of Jones (1931) and those of Nelson (1931) to the effect that the use of superphosphate decreased the yield of rice.

Combination of N and P_2O_5 no better than N alone

Inspection of the data in tabulation 1 reveals, that under the criteria of results employed, neither culture XIV nor culture XV, which received both ammonium sulfate and superphosphate was any better than culture II, which received only ammonium sulfate. It may, then, be concluded that under the conditions of this study, that is, when the gross quantity of the fertilizers or fertilizer mixture was the same, addition of superphosphate as previously discussed and of superphosphate and ammonium sulfate to tuff soil was either harmful or less beneficial to the rice plant than when the culture was supplied with sulfate of ammonia only.

Rice plant grows well in tuff soil without addition of K_2O

Results from this study show that rice plant throve well in tuff soil when sulfate of ammonia was added. In tables 1 to 4 may be seen data that indicate fairly well the vigor and stand of the rice plant. The plants in figures 1 and 2 are both illuminating and convincing. These rice plants were grown on tuff soil which received no potash fertilizers. Only N and P_2O_5 bearing fertilizers were used. The stand of the plant was so satisfactory, especially in cultures listed in tabulation 1, that one could not help but suspect that *complete* fertilizers were employed. As shown in the tabulation 1, however, no potash bearing fertilizer was used, hence the tuff soil that was used in this study was evidently rich in potash.

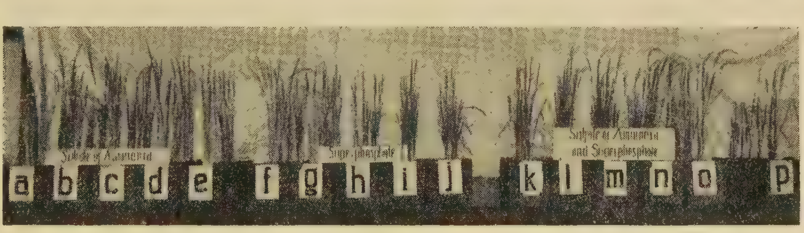

Fig. 5.—Showing the rice plants grown in the soil previously used in the first test or for the *initial effect* of the fertilizers. Photographed on December 28, 1933 when the plants were 16 weeks old.

The N-P_2O_5-K_2O that gave the best growth to the rice plant

As shown in the preceding discussions, culture II was found to be the best of all the cultures tested. As shown by the data in tabulation 1, this culture was fertilized with 4.14 grams of ammonium sulfate which supplied the two plants in each culture 0.85 gram of N. In other words, no fertilizing element was added to the soil except 0.85 gram of N and those that were derived from the water. The plants, however, received equal amounts of water. If the fertilizing element from the fertilizer and those from the soil were added together, culture II would have 27.45 grams of N, 91.20 grams of P_2O_5, and 95.00 grams of K_2O. In this study, it was found that the N-P_2O_5-K_2O ratio that gave the best growth and development and high yield of grain was 27.45-91.20-95.00.

The residual effects

Not much can be said about the tests on the *residual effects* of the fertilizers. This is because all the plants in the culture, (tables 5 to 7 and fig. 3B, 4B and 5) were poorly developed and extremely non-productive. In most of the cultures, however, the beneficial effects of the fertilizers were felt by the plants in the second culture, although, only to a very slight degree. In several cases, the results obtained from the *control* cultures were only slightly inferior to or poorer than the corresponding results that were obtained from the residual effect tests. This might be due to the fact that part of the fertilizers were lost through leaching through the drainage holes of the cans. In other words, the apparently very small amounts of ammonium sulfate, superphosphate, and certain combinations of these two fertilizers (see data in tabulation 1) could not be consumed entirely in one season or generation by the two plants that were grown in each pot containing tuff soil. The culture II, which turned out to be the best culture under the criteria of results employed, received only 4.14 grams of ammonium sulfate, or at the rate of three-fourths of a ton per hectare.

SUMMARY AND CONCLUSIONS

Rice plants, variety Inintiw, were grown to maturity in tuff soil, or the subsoil of the Lipa clay loam soil in pots, fertilized with either ammonium sulfate or superphosphate, or mixtures of these two fertilizers. Unfertilized cultures, control, were included. From the results of this study based largely on (*a*) number of tillers, (*b*) height of plants, (*c*) air-dry weight of roots, (*d*) air-dry weight of straw, and (*e*) air-dry weight of full grains, the following conclusions may be drawn:

1. Addition of superphosphate or of P_2O_5 alone to tuff soil, or the subsoil of the Lipa clay loam soil proved to be harmful to the rice plant, confirming findings of Jones (1931) and Nelson (1931).

2. When the gross quantity of the fertilizers or fertilizer mixtures was the same, addition of mixture of superphosphate and ammonium sulfate to tuff soil was either harmful or less beneficial to the rice plant than when the culture was supplied with sulfate of ammonia only.

3. The results from this study show that the rice plant can grow normally in tuff soil without the addition of K_2O when sulfate of ammonia was supplied.

4. The best growth and the development of the plant and high yield of grain were obtained with 4.14 grams of ammonium sulfate per pot culture of two plants or 0.85 grams of N.

5. When the nutritive ingredients from the fertilizer and those from the soil were added together, the best culture (culture II) was found to contain 27.59 grams of N, 91.20 grams of P_2O_5, and 95.00 grams of K_2C. In other words, the N- P_2O_5-K_2O ratio was 27.59–91.20–95.00.

6. In most of the cultures, the benefits of the fertilizers used were still effective on the plants in the second culture, although, of course, only in a very slight degree as some of the fertility had probably leached away through the drainage holes, and had been absorbed by the preceding crop.

LITERATURE CITED

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TABLE 1

Average harvest data of an upland rice grown in tuff soil in pots as influenced by sulfate of ammonia and superphosphate when applied singly or in certain combinations. (Experiment from April 22, 1933 to September 2, 1933)[a]

CULTURE NO.	NUMBER OF TILLERS	HEIGHT	AIR-DRY WEIGHT OF				EXTERNAL APPEARANCE OF PLANTS AT HARVEST
			roots	straw	full grains	empty grains	
		cm.	*grams*	*grams*	*grams*	*grams*	
I	33.0H	115.1H	61.9H	75.6H	51.17	4.56	Luxuriant
II	31.3H	115.1H	56.4H	63.8	56.63H	3.65	do
III	30.0	107.0	51.8	63.1	61.13H	3.68	do
IV	28.8	91.5	29.6	32.5	36.06	2.96	Normal
V	25.5	88.0	17.7	23.2	30.07	1.66	do
VI	8.8	75.6	14.9	16.6	8.98	1.01	Stunted
VII	6.3	74.0	13.3	13.5	8.04	1.07	do
VIII	6.5	75.6	12.0	12.6	7.93	1.14	do
IX	6.0	76.0	11.0	10.0	7.40	0.71	do
X	7.8	75.6	8.8	9.1	6.36	0.51	do
XI	23.5	97.8	33.8	51.4	25.79	1.58	Normal
XII	25.3	101.1	34.7	53.0	25.91	2.76	do
XIII	28.5	108.7	39.1	54.2	35.34	1.96	Luxuriant
XIV	31.0	115.6H	44.6	72.0H	39.90	1.84	do
XV	31.3H	122.0H	72.7H	84.6H	55.60H	2.83	do
Control	8.0	81.1	13.3	13.4	9.40	0.58	Stunted

[a] The fertilizers and the fertilizer mixtures that were used in this set of cultures may be found in tabulation 1.

TABLE 2

Average harvest data of an upland rice grown in tuff soil in pots as influenced by sulfate of ammonia and superphosphate when applied singly or in certain combinations. (Experiment from May 27, 1933 to September 30, 1933)[a]

CULTURE NO.	NUMBER OF TILLERS	HEIGHT	AIR-DRY WEIGHT OF				EXTERNAL APPEARANCE OF PLANTS AT HARVEST
			roots	straw	full grains	empty grains	
		cm.	*grams*	*grams*	*grams*	*grams*	
I	42.3H	140.0H	137.4H	191.9H	75.82H	1.65	Luxuriant
II	42.3H	157.9H	129.6H	186.5H	79.28H	2.13	do
III	34.3	133.0H	110.6H	133.6H	82.98H	1.28	do
IV	26.3	117.3	66.8	72.7	56.55	0.83	Normal
V	25.0	101.6	52.2	65.3	45.89	0.39	do
VI	10.1	69.4	10.8	11.9	10.19	0.31	Stunted
VII	8.8	62.3	9.2	9.1	8.39	0.09	do
VIII	7.0	63.5	8.7	8.2	7.63	0.42	do
IX	7.3	61.3	7.8	7.9	6.89	0.12	do
X	8.0	68.8	9.0	7.8	7.82	0.38	do
XI	21.0	88.4	33.8	41.3	33.91	0.52	Normal
XII	20.3	96.9	46.3	56.7	36.93	1.21	Luxuriant
XIII	24.8	103.7	59.4	68.7	45.99	0.89	Normal
XIV	35.0	116.6	86.1	112.7	52.10	1.00	do
XV	35.8H	119.1	101.1	130.3	66.68	1.22	Luxuriant
Control	14.8	103.4	13.8	22.4	12.27	0.53	Normal

[a] The fertilizers and the fertilizer mixtures that were used in this set of cultures may be found in tabulation 1.

TABLE 3

Average harvest data of an upland rice grown in tuff soil in pots as influenced by sulfate of ammonia and superphosphate when applied singly or in certain combinations. (Experiment from November 18, 1933 to March 2, 1934)[a]

CULTURE NO.	NUMBER OF TILLERS	HEIGHT	AIR-DRY WEIGHT OF				EXTERNAL APPEARANCE OF PLANTS AT HARVEST
			roots	straw	full grains	empty grains	
		cm.	*grams*	*grams*	*grams*	*grams*	
I	25.3H	98.4	22.2H	59.6H	14.48H	1.08	Normal
II	19.3	97.8	15.0H	42.8H	13.28	0.94	do
III	18.8	98.8	13.5	42.3	15.43H	0.74	do
IV	16.3	90.0	9.2	32.9	9.64	0.76	do
V	14.5	85.4	8.8	25.2	8.92	0.41	do
VI	4.8	77.3	2.2	7.6	1.91	0.01	Stunted
VII	5.0	63.8	2.4	6.2	2.16	0.03	do
VIII[b]	3.3	60.2	1.6	5.1	1.72	0.05	do
IX	3.5	72.7	3.0	6.6	2.50	0.10	do
X	3.5	74.4	2.7	5.9	2.17	0.02	do
XI	13.5	86.3	6.6	18.9	8.40	0.77	Normal
XII	15.0	99.4H	11.7	30.3	12.24	0.69	do
XIII	17.0	96.6	11.7	29.5	12.39	1.41	do
XIV	22.0H	100.8H	14.8	42.1	13.91	0.97	do
XV	25.3H	111.0H	15.8H	53.8H	18.67H	1.11	Luxuriant
Control	6.0	70.1	4.2	12.4	6.16	0.11	Stunted

[a] The fertilizers and the fertilizer mixtures that were used in this set of cultures may be found in tabulation 1.

[b] One plant died.

TABLE 4

Average harvest data of an upland rice grown in tuff soil in pots as influenced by sulfate of ammonia and superphosphate when applied singly or in certain combinations. (Experiment from March 17, 1934 to August 2, 1934)[a]

CULTURE NO.	NUMBER OF TILLERS	HEIGHT	AIR-DRY WEIGHT OF roots	AIR-DRY WEIGHT OF straw	AIR-DRY WEIGHT OF full grains	AIR-DRY WEIGHT OF empty grains	EXTERNAL APPEARANCE OF PLANTS AT HARVEST
		cm.	*grams*	*grams*	*grams*	*grams*	
I	41.8H	101.6	41.6H	90.5H	54.49H	1.09	Luxuriant
II	42.0H	103.4H	43.5H	71.2H	58.67H	0.74	do
III	31.8	97.9	27.7	52.3	46.41	0.51	do
IV	21.5	83.8	22.0	30.1	34.74	0.38	Normal
V	19.5	70.7	11.9	19.9	28.28	0.40	do
VI	12.5	58.2	4.6	11.5	5.77	0.19	Stunted
VII	10.0	58.1	3.2	9.0	5.60	0.10	do
VIII	9.5	54.4	4.1	8.9	5.23	0.09	do
IX [b]	8.8	61.0	3.2	8.3	4.58	0.05	do
X [b]	8.0	56.1	2.8	7.8	4.50	0.08	do
XI	20.8	73.3	13.2	22.2	17.83	0.14	do
XII	27.3	86.6	16.0	26.1	20.10	0.43	Normal
XIII	35.8	95.1	24.4	47.3	28.19	0.63	Luxuriant
XIV	27.3	103.6H	24.3	26.1	42.22	0.76	do
XV	40.3H	103.5H	31.4H	79.5H	50.91H	1.24	do
Control	11.5	54.7	5.6	10.4	6.81	0.30	Stunted

[a] The fertilizers and the fertilizer mixtures that were used in this set of cultures may be found in tabulation 1.

[b] One plant died.

TABLE 5

Average harvest data of an upland rice grown in tuff soil in pots in the first residual effect test of sulfate of ammonia and superphosphate when applied singly or in certain combinations. (Experiment from September 16, 1933 to January 17, 1934)

CULTURE NO.	NUMBER OF TILLERS	HEIGHT	AIR-DRY WEIGHT OF				EXTERNAL APPEARANCE OF PLANTS AT HARVEST
			roots	straw	full grains	empty grains	
		cm.	*grams*	*grams*	*grams*	*grams*	
I ..	6.5	74.0	6.3	14.1	7.72	0.49	Stunted
II ..	5.8	72.8	10.8	14.5	7.73	0.59	do
III ..	5.8	72.9	8.1	14.7	7.08	0.11	do
IV ..	6.3	73.7	8.2	13.8	6.61	0.08	do
V ..	5.0	72.3	7.1	13.6	6.08	0.08	do
VI ..	5.3	73.7	10.4	13.0	5.35	0.08	do
VII ..	5.0	71.8	10.4	14.8	5.03	0.07	do
VIII ..	4.5	69.3	9.2	10.4	5.17	0.07	do
IX [a] ..	3.8	62.6	11.0	15.2	5.15	0.07	do
X ..	4.0	68.9	7.5	12.1	5.07	0.07	do
XI ..	5.3	71.8	8.2	13.2	7.01	0.12	do
XII ..	6.0	72.4	8.3	15.2	7.10	0.09	do
XIII [a] ..	4.5	75.7	7.6	10.5	6.38	0.07	do
XIV [a] ..	6.0	77.3	8.2	15.3	6.42	0.07	Normal
XV ..	5.5	76.2	9.1	14.7	8.15	0.29	do
Control ..	5.8	66.7	6.4	9.5	4.54	0.04	Stunted

[a] One plant died.

TABLE 6

Average harvest data of an upland rice grown in tuff soil in pots in the first residual effect test of sulfate of ammonia and superphosphate when applied singly or in certain combinations. (Experiment from December 2, 1933 to March 29, 1934)

CULTURE NO.	NUMBER OF TILLERS	HEIGHT	AIR-DRY WEIGHT OF				EXTERNAL APPEARANCE OF PLANTS AT HARVEST
			roots	straw	full grains	empty grains	
		cm.	*grams*	*grams*	*grams*	*grams*	
I ..	5.8	81.1	1.4	6.5	2.67	0.05	Stunted
II [a] ..	3.5	84.0	0.8	3.2	2.01	0.03	do
III ..	4.5	80.8	1.1	4.2	2.29	0.04	do
IV ..	4.5	77.9	1.0	4.0	2.24	0.04	do
V ..	4.5	81.2	1.0	3.9	2.30	0.04	do
VI ..	5.5	80.8	1.2	4.9	3.11	0.05	do
VII ..	5.3	83.0	1.2	4.3	3.20	0.04	do
VIII ..	4.5	83.5	1.2	3.9	1.09	0.04	do
IX ..	4.5	82.3	1.1	4.0	2.27	0.05	do
X ..	4.3	82.3	1.0	3.7	2.15	0.04	do
XI ..	6.3	80.1	1.5	5.2	2.66	0.06	do
XII [b] ..	5.8	85.8	1.2	5.2	2.70	0.05	do
XIII ..	5.5	86.0	1.5	5.7	2.82	0.09	do
XIV ..	5.5	82.0	1.3	5.8	2.87	0.07	do
XV ..	5.8	82.8	1.6	6.5	3.97	0.07	do
Control ..	5.8	85.1	1.1	3.9	2.40	0.05	Stunted

[a] Two plants died.
[b] One plant died.

TABLE 7

Average harvest data of an upland rice grown in tuff soil in pots in the first residual effect test of sulfate of ammonia and superphosphate when applied singly or in certain combinations. (Experiment from March 17, 1934 to August 2, 1934)

CULTURE NO.	NUMBER OF TILLERS	HEIGHT	AIR-DRY WEIGHT OF				EXTERNAL APPEARANCE OF PLANTS AT HARVEST
			roots	straw	full grains	empty grains	
		cm.	*grams*	*grams*	*grams*	*grams*	
I ..	12.0	61.3	6.0	13.0	7.00	0.79	Stunted
II ..	11.8	64.4	5.3	12.3	5.88	0.08	do
III ..	10.5	61.2	4.3	9.8	4.61	0.10	do
IV ..	9.5	54.8	4.1	7.8	5.28	0.07	do
V ..	7.8	53.6	3.9	9.3	5.31	0.08	do
VI[a] ..	9.3	47.9	2.8	7.5	3.62	0.06	do
VII ..	8.0	48.2	3.5	8.3	4.11	0.05	do
VIII ..	8.5	50.4	7.0	2.9	3.95	0.05	do
IX ..	7.6	52.9	2.8	8.2	4.66	0.06	do
X ..	10.5	57.9	2.7	10.6	4.71	0.05	do
XI ..	10.0	56.0	4.3	11.5	5.91	0.11	do
XII ..	10.3	56.5	4.7	10.0	6.21	0.03	do
XIII ..	9.5	57.1	5.4	10.5	5.67	0.10	Normal
XIV ..	10.8	57.8	5.1	10.8	6.44	0.14	do
XV ..	10.8	60.6	5.7	11.5	6.44	0.14	do
Control ..	7.3	46.7	2.6	6.2	4.59	0.08	Stunted

[a] One plant died.

ABSTRACTS[1]

A comparative plot test of inbred rice strain No. 518-8-36 with the local Hambas rice variety. SEGUNDINO O. BARRAQUERO. (*Thesis presented for graduation, 1935, with the degree of Bachelor of Agriculture, from the College of Agriculture, No. 481; Experiment Station contribution No. 1083*)—The object of this study was to compare the yielding power and other important characteristics of No. 518-8-36 inbred strain of Hambas rice with the local Hambas rice variety and at the same time to propagate this strain under College conditions.

The author used three and one-half gantas of the seed of the Hambas strain No. 518-8-36 and three and one-half gantas of the local Hambas rice variety to match the strain under study.

The seeds were soaked in water for 24 hours and then allowed to germinate for two days. The germinated seeds were then sowed in a seed bed 40 sq. m. in area.

Forty days after sowing the seeds, the seedlings were pulled up and transplanted in the field, two seedlings to a hill.

The author found that:

(1) About 4.6 per cent of the grains of the inbred strain and about 22.6 per cent of the grains of the local Hambas rice variety were red cuticled.

(2) The inbred strain and the local Hambas rice matured in 184 days.

(3) The inbred strain had an average height of 140.23 cm., the local Hambas, 142.54 cm.

(4) The head or panicle formation of the inbred strain was uniform, that of the local Hambas was not.

(5) The inbred strain matured more uniformly than the local Hambas rice variety.

(6) The average computed yield of the inbred strain was 62.8 cavans per hectare, that of the local Hambas, 55.2 cavans.

(7) No other rice varieties were found mixed with the inbred strain. Ramai, Elon-elon and Malagkit Sungsong rice varieties were found mixed with the local Hambas.

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[1] Abstracts prepared as part of theme work required in English 3a, College of Agriculture.

(8) It was recommended that for planting, the inbred strain No. 518-8-36 should be used rather than the local Hambas rice variety.

—Abstract by Rasuman Macalandong

A study of the germination of the soaked, unsoaked, husked and unhusked cane points and stand of the plants arising therefrom. MAXIMINO S. CORTEZ (*Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture No. 482; Experiment Station contribution No. 1084*)—The author worked on three objects: (*1*) To determine the effects of husking upon the germination of sugar cane points; (*2*) to determine the effects upon germination of soaking seed pieces of sugar cane in running water; and (*3*) to determine the effects of the various treatments upon the stand and development of sugar cane.

In the experiment, 11,600 apparently uniform seed pieces of Luzon White cane were used, 5,800 were husked and 5,800 were unhusked. Selected points were bundled. Each bundle contained 113 to 115 points and from these, 100 points were finally selected for planting. The bundled seed pieces were divided into groups. Each group contained four bundles, two bundles were husked and the other two were unhusked. One group was soaked in running water. The points that were soaked were divided into sets according to length of time they were soaked. One set was put in the water every six hours, the set soaked for 168 hours was placed in the water first; six hours later, the set soaked 162 hours was placed in the water and so on. The soaked seed pieces were placed in the shade for 24 hours before planting. The oblique method of planting was used. The points were planted 75 cm. apart in rows which were one meter apart. The first four rows were planted to the unsoaked seed pieces, the next four rows to seed pieces soaked for different lengths of time. The husked and unhusked points that were similarly treated were planted side by side.

The new shoots that sprouted daily in each group were counted and recorded separately. Weekly measurements of growth were made for fourteen weeks. The total heights and diameter and number of tillers of each plant under study were recorded.

The author found that: (1) Under field conditions the germination of the unhusked seed pieces was better than that of the husked seed pieces. (2) The greater difference in germination between the unhusked and the husked seed pieces was obtained from 24 hours soaking in water. (3) The soaked seed pieces had a higher percentage of germination than the control. The best results were obtained from the seed pieces soaked from 24 to 90 hours in running water. (4) The unhusked seed pieces gave a better stand of plants than the husked. (5) Husking did not show any effect upon the height of plants but it affected slightly the diameter and the degree of tillering of the plant. (6) Soaking both husked and unhusked seed pieces slightly increased the height and diameter of the plant. (7) Soaking did not affect the degree of tillering of the sugar cane plants.

—Abstract by Conrado C. Dinulos

CURRENT NOTES

Lime is absolutely essential to healthy plant life and animal life. We see the value of this mineral in its relation to healthy development. It is produced by calcinating lime-stone, marble or sea shells, yielding the anhydrous calcium oxide known as quicklime, which with water, forms slaked lime. It also readily absorbs moisture from the air forming air-slaked lime. In any of these forms it may be applied to soil—the form to apply depending upon the purpose for which the application is made. . . .

The idea that it is generally applied for manurial purposes is erroneous. It is only when it is entirely different from the soil that it is applied as a manure—in a small quantity. It is, however, absolutely essential to healthy plant life, making the plant food already in the soil more available to the roots, and liberating other elements from the soil. Soil, however, often contains sufficient lime to cope with the needs of plant life, but in cases where it is quite destitute of this essential mineral, its application is highly necessary, having a most effective influence on the useful bacteria in the soil upon which depends, to a large extent, the success of our gardening efforts and crop raising.

Lime has also been proved to be invaluable as an insect killer and fungoid destroyer—and can be applied beneficially to both clayey and sandy soils.

The Planter (F.M.S.), June, 1935.

The avocado was known to the Spanish conquistadores in Mexico as "aguacate", and Salazar, writing in 1554, calls it by that name. . . .

The accepted present English name, avocado, is of course derived from the Spanish variant of the old Aztec name. . . .

Hawaii received avocado seeds from Central America before 1825, chiefly of the West Indian race but also some Guatemalans. Introductions intc many other countries have come in recent years, and now avocados are cultivated in Algeria, Australia, the Canary Islands, southern France, Madagascar, Madeira, Mauritius, New Zealand, Palestine, the Philippine Islands, Polynesia, South Africa and southern Spain, as well as all over the West Indies, Central America, Mexico, and the northern half of South America.

The Tropical Agriculturist, April, 1935.

Most people connected with agriculture ask themselves at some time or another why the rotation of crops is universally practised in good farming districts. If the soil of a particular field suits a certain crop, why should not this crop be grown year after year upon the same land, The cultivations and manuring are the same each year, so that tilth and feeding conditions ought to approach the ideal the more frequently the crop occupies the same area. . . .

Generally the reason given for rotations is the necessity for cleaning the land, and other considerations are neglected. Rotations do give the farmer an opportunity of ridding his farm of weeds, but, in addition, the judicious alternative of different crops brings in its train the following advantages: the control of insect and fungus pests, the fullest utilization of the food reserves of the soil, the storage of fertility, and convenience in carrying out farm operations. . . .

A great advantage which follows the alternation of crops is that different layers of the soil are explored by the varying lengths of roots belonging to farm crops. . . .

A still further advantage which follows from the employment of both shallow and deep-rooted plants is this, that the deep-rooted plants, through the eventual decay of their large tap and secondary roots open up the compact subsoil of stiff land thereby promoting the drainage and aeration of the lower layers.

The Farmers' Gazette, (Ireland) June, 1935.

Difficulty was experienced with the cowpeas when cutting for silage making, the soybeans being much more satisfactory in this respect. The Otootan soybean and Victor cowpea were the most favoured by the experimenters when making their silage, and were ensiled in the proportion of one load of legume to three loads green maize when chaffing into the silo. On inspection this mixed silage appeared to have cured quite satisfactorily.

The Agricultural Gazette of South Wales, April, 1935

Bruised and skinned knuckles, caused by the cranking handle slipping while starting the farm engine, may be easily prevented. Cut a circular piece the size of a dinner-plate from a petrol-tin. Punch a hole in the centre and remove a 3-inch segment; make two cuts from the outer edge to the hole. Bring the edges together and fasten with a rivet. You have now a shallow cone; slip this over the handle and there will be no more danger when starting up.

Queensland Agricultural Journal, April, 1935.

An innovation in shows was held at Alor Star, Kedah, on 13th and 14th March, 1935, when a successful padi show took place, the exhibits consisting entirely of selected high-yielding strains of padi which had been grown by planters from seed distributed by the local Department of Agriculture. . . .

Each exhibit consisted of one gantang of padi contained in a bamboo basket of suitable shape and size. This arrangement proved most suitable and convenient for displaying the samples, the total number of which was 654. In addition, there was a large Departmental Stand, on which were shown padi and ears of thirty-two selected pure lines grown at Telok Chengai. Charts showing the average monthly rainfall over a period of 20 years, as well as the crops of padi of the last 11 years compared with the acreage planted, were exhibited. A series of photographs of manurial and other experiments on Kedah experimental stations was included.

The Malayan Agricultural Journal, April, 1935

COLLEGE AND ALUMNI NOTES

Mr. J. M. Westgate, Professor of Tropical Agriculture in the University of Hawaii, who is touring tropical countries to obtain a general idea of agricultural conditions and practices, and of the production and uses of important crops in these regions arrived at the College of Agriculture October 22. His itinerary included one week in the Philippines. He spent fully six days of this time at the College. The day after his arrival he was taken by Dr. N. B. Mendiola of the Department of Agronomy to various coconut plantations and to places where coconut products are manufactured in Laguna Province. They saw many typical coconut plantations and visited The Franklin-Baker desiccated coconut factory in San Pablo, a distillery in Lilio manufacturing wine from coconut sap, a large oil factory in Magdalena, a large copra factory in Santa Cruz and several small ones in other towns. Professor Westgate was the guest of Doctor Mendiola at a luncheon at the Hotel Fabella in Pagsanjan.

Professor Westgate had planned to spend only two or three days of his week in the Philippines at the College and the rest of the time in Baguio. But he liked our climate so well that he decided to exclude the Mountain City this time and stay on the Campus visiting our different departments and different cultures in our Economic Botanical Garden and writing up his notes on China and what he saw here. He went from the Philippines to the Federated Malay States and Java. In appreciation of the hospitality extended him by the College, Professor Westgate donated a loving cup to the College of Agriculture Rural High School to be competed for yearly in athletics and awarded each year to the class winning the championship.

The S. A. R. meeting for the initiation of new members was held on October 17 in the Auditorium. The members initiated were M. C. Chakrabandhu and Francisco R. Lopez, who were received as associates. Preceding the meeting the S. A. R. gave a dinner in Molawin Hall for Dr. H. Windsor Wade the guest of honor and speaker for the evening and the two new members.

Doctor Manresa, the Vice President gave the address of welcome and Dean Gonzalez, the President received the new members and introduced the speaker for the evening.

Doctor Wade is one of the officials in the Leonard Wood Memorial Fund and Chief Leprologist in Culion. He gave a most interesting address on leprosy, its history, different theories as to its cause and treatment. Of course, he also spoke on the work in the Islands. He paid warm tributes to his fellow workers at the Eversley Childs Leprosarium in Cebu and in the Culion Colony.

The one-hundred- and-seventh regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Plant

Physiology Building, College of Agriculture, on October 31, 1935, at 7:30 o'clock in the evening.

The following papers were read and discussed:

"The fertilizing constituents in the solid excreta of sheep and goats."
By Dr. Valente Villegas and Mr. L. A. Ynalvez
Paper was read by Mr. Ynalvez

"Studies on the performance of an eight cylinder engine using gasoline, dehydrated alcohol, and dehydrated alcohol-gasoline mixture".
By Dr. A. L. Teodoro

"Method of constructing mushroom beds in Southern China".
By Dr. R. B. Espino

Mr. Felipe Crisostomo '33 who worked for more than a year under Dr. Felipe Adriano, research chemist in the Magnolia Milk and Ice Cream Products, proved so competent that he was sent last June to Calcutta as Superintendent of the Magnolia plant recently established in that city.

Mr. Jose Quintos '33 writes that he is now teaching in the Upi Agricultural High School, Cotabato. Recently, under his direction, the pupils had a torch light procession planned, Mr. Quintos wrote, after the Campus processions in which he had taken part. From the comments of those who saw it this procession was quite an event in the community. Again, showing that our students acquire useful knowledge in our College outside the classroom. Mr. Quintos had been to visit Mr. Aniceto Padilla '31 on his homestead. "Mindanao is a grand place" is Jose's verdict.

Mr. Segundino Barraquero '35 has been appointed as laboratory assistant at the Culion Colony in the Leonard Wood Memorial Leprosy Work.

Under the auspices of the Order of the Pterocarpus, School of Forestry on the evening of November 9, at the Social Center, the U. P. Debating Club gave their twentieth provincial debate.

The subject was:

Resolved; "That the right to engage in retail trade be granted to Filipino and American citizens only".

The judges awarded victory in the contest to the negative side.

The Secretary's office reports that the following students received marks of distinction at the close of the first semester of the academic year, 1935-1936, based on the final ratings in October:

RANK	NAME	AVERAGE RATING[1]	ACADEMIC LOAD[2]	CLASS
1st	Luis, Victor V.	1.15	17	2nd Year, B.S.A.
2nd	Alconcel, T. Q.	1.25	20	2nd Year, B.S.S.T.
3rd	Zialcita, Lorenzo,	1.54	22	2nd Year, B.S.A.
4th	Luna, Jose G.	1.62	18	2nd Year, B.S.A.
5th	Macaspac, Isidro	1.76	17	2nd Year, B.S.S.T.
6th	Castro, Alfonso	1.83	22	1 st Year, B.S.A.
7th	Rigor, Ernesto L.	1.88	18[3]	4 th Year, B.S.A.

[1] The average rating was computed by multiplying the final rating obtained by the student in each course by the number of units carried by such course and dividing the sum of the products by the total number of units carried by the student.

[2] Only students carrying regular loads (minimum of 15 units for working students and 20 units for regular students) were considered.

[3] Excluding credits on thesis.

The English 1b classes on November 14, the day preceding the inauguration of the Commonwealth, in the recitation hour, each presented a program appropriate to this important occasion. The instructor, Professor Cole suggested the plan but each class arranged and prepared, without assistance, its program. The results, particularly in the ideas expressed in the speeches, were most gratifying.

Despite the great extent of modern university curricula, one field of paramount importance to everyone is barely touched upon, the social and political situation of the present time. . . . The newspapers and politicians are alike useless; the former because by nature inadequate, are infrequently well read, still more infrequently digested, and the latter because they have usually their own axes to grind. The university remains today virtually the only available institution for the dissemination of true knowledge of the present. *The Harvard Crimson.*

Reprinted in *What the Colleges are Doing*, January, 1935.

THE THIRD INTERNATIONAL CONGRESS OF SOIL SCIENCE[1]

FROM THE NOTEBOOK OF A SOIL TECHNOLOGIST

FROM BANGKOK TO LONDON

As I reached Bangkok only about a week before the opening of the Third International Congress of Soil Science in Oxford, England, travel by plane was the only possible way to reach England in time. Actually, not only the trip to the Congress was made by plane, but the return trip also, with a detour via Rome, returning to the main line at Athens, was made by the same mode of travel. By the Royal Dutch KLM line I made the trip from Bangkok to London in four days with very little travel after dark. Stopped at the best hotels on the route overnight. My notebook was always at hand and frequently in use; since so many things of interest in agriculture and related lines were seen, which it is believed will also be of more than passing interest to students of Philippine agriculture. It seems worth while to record some of them here, in addition to brief descriptions of the Soil Congress and the International Institute. To sit in an easy chair, three kilometers above the earth and for hours together travel at two hundred-sixty kilometers an hour, yet with no sense of motion, and to comfortably view in rapid succession the places where, under mutually differing conditions, for forty centuries man has been trying to solve the problems of life and the hereafter, is to compel the spectator to evaluate life anew. What a multitude of associations and conflicting ideals these cities recall—Rangoon, Calcutta, Benares, Allahabad, Jodhpur, Karachi, Bushire, Bagdad, Jericho, Jerusalem and Bethlehem, Heliopolis and Cairo, Athens, Corinth, Rome, Venice, Budapest, Munich, Cologne, Amsterdam, Rotterdam, London!

Our route passed above many of the historic foci of human activity: India, Babylonia, Palestine, Egypt, Greece, Italy, Germany, Holland, and England. The aridity of the first four of these regions, and the magic touch of irrigation impresses one strongly. On the lower sides of irrigation ditches were great expanses of green crops, while just above the ditch the light brown or gray, bare, usually sandy

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[1] Miscellaneous contribution No. 13. Received for publication October 23, 1935.

desert stretches away for hundreds of thousands of kilometers. What a large proportion of the farmers' efforts have been devoted to irrigation of land! But desert soil is rich and responds well to water used in moderation, and doubtless most of the problems of irrigation were more easily solved and less difficult than the combating of human and plant diseases which are more serious in regions of abundant rainfall. While there is a rapidly increasing realization that climates have changed with the evolution of the world, it is not so certain that climates have significantly changed since the dawn of history. Yet the abandoned irrigation works and other signs of habitation during ancient times in Babylonia, where now the region seems to be completely desert make one wonder if there has not been increasing desiccation with the passage of time. Everywhere accompanying irrigation was evident the result of that terrible soil affliction "alkali" spots or blotches, small or often grown to many hectares in size, because of the application of excessive quantities of irrigation water.

The trip was a panorama of physiographic and geological exhibits, particularly in the desert regions along the coasts of Baluchistan and Iran. The erosional forms and geological structures exposed (in the desert there is no vegetation to obscure the completeness of the geological picture) are superb, far excelling the illustrations in any textbook. How I wished that I could show the students in my agricultural geology class that marvellous display! Then the vast wastes of the Syrian desert, with evidences of man's struggle to cross and to transport goods—by camel, by automobile, by pipe line, and by railway, and now the line of peculiar landmarks to enable the aviator to cross even in the face of dust storms, the fearful enemy of planes. Once on our trip we went through some clouds of dust and dodged around others, while we could occasionally see more dust rising from the ground in curious curls; after that we were thankful to leave the cool upper air and at sunset land at Bagdad for the night, even though the temperature there on the ground at sunset was about 45°C.!

Having struggled, so often apparently without result, in trying to teach students to read maps, I was much interested to see how many of the passengers by plane were keenly interested in maps and used them. In fact, most of the passengers used quite seriously the maps of the routes travelled; usually such maps were supplied to each passenger at the beginning of each journey on the European lines. For that matter, it was very noticeable that the educated public in Britain as a whole, with the abundant supply of good maps for sale, is much more map-conscious than anywhere I have been before.

How startlingly clear were the marks of the meandering of the Danube, the Ganges and the Irrawady! The Bramaputra demonstrated very clearly all the features of deltas: The muddy sea, shallower muddy water near shore, mangroves, poor salty rice fields, better rice fields, villages along the natural levees, and better and more permanent cultivation at a considerable distance from the sea.

Almost everywhere the shape and size of fields, the forests, the location of the pasture land, the number and nature of the villages, while in a measure depending upon custom and governmental action, clearly differed in various regions; yet the agricultural pattern was evidently fitted to and determined in its broad principles and features by the physiography, the geology, and the climate of the locality. Some regions have compact villages, others straggling villages extending far along the main roads, a good deal as the barrios extend along Philippine roads, and in still other regions the farmsteads are located on the separate farms. A striking difference was evident between Siamese rice fields and those of neighboring countries to the west. In Siam the farms are not often leveled, so that there are conspicuous many ponds or deeper places here and there in the fields. The Siamese cultivator makes up for this irregular depth of water in his fields by use of deep water rice when needed. Such varieties may be transplanted into water as deep as eighty centimeters.

It is indeed an ill wind that blows nobody good! The leaden black skies and heavy thunder storms over Central India which caused our pilot to turn back to Allahabad for the night, and which meant tardy arrival at the congress, gave me an opportunity to visit the Allahabad Agricultural Institute. The institution, where more than seventeen years ago I commenced my apprenticeship in Far Eastern agriculture, had grown so much, that to me, it was hardly recognizable. Space forbids doing justice here to the many lines of activity in which commendable progress is being made by the large, well qualified, and experienced staff. High lights in memory, perhaps not the most important, but at least more interesting to me were: The cheap and practical plow for the small cultivator, methods for the control of weeds, improved design of reinforced brick floors and roofs for Indian buildings, the radio station for broadcasting agricultural information, the reclamation of seriously gullied fields, the conservation of organic matter and its conversion into an excellent fertilizer by the Howard method, the progress in crossing Occidental breeds of cattle with the local stock, and the modern and well equipped dairy. India is such a vast country, with so very many as yet entirely untouched, much less unsolved, agricultural problems that this quite unofficial contribution by unselfish friends of the Indian farmer deserves no little encouragement.

As we passed over the upper end of the Dead Sea, just where the delta of the muddy, disappointingly small Jordan River enters it, we saw below us the evaporating ponds and refinery where modern chemistry is working miracles in extracting fertilizer salts and other useful chemicals from the very salty waters of that lake.

The results of centuries-long cultivation of the shallow hilly soils of Palestine, Crete, Greece, and Italy are all too evident. Little terracing has been done, for there never has been water for irrigation which might have made irrigated rice possible. Now, in many cases nothing but the bare rock remains on the hills, with only a little soil here and there in pockets. The greater erodability of soils developed from limestone rocks was quite evident.

In northern and western Europe one of the very striking features of the landscape are the forests which, it is evident, are carefully managed. In those regions forest trees are often considered just as much of a crop as anything else which may be raised upon the land.

THE THIRD INTERNATIONAL CONGRESS OF SOIL SCIENCE

During the last few days of July and the first week of August, 1935 the Third International Congress of Soil Science met in Oxford, England. In attendance were about four hundred and thirty delegates, of which about three hundred and eighty were scientific members. These delegates came from about forty countries, and represented almost the whole inhabited world. During the mornings were held the general meetings, at which outstanding leaders presented comprehensive papers upon the broad fields in which they were especially interested and qualified. In the afternoons there were held simultaneously the meetings of the several sections into which the membership of the International Society of Soil Science is divided. Each morning was issued a program, giving the titles of papers, the authors, the sections in which, and the time when the paper would be presented that afternoon. Thus it was possible for the member of one section, without being absent long from his section, to listen to a paper and take part in the discussion in any other section.

It was very interesting to observe the increased use of English at this Congress, in comparison with its use in publications of even only a decade ago. As a scientific tool as well as a medium of communication in commerce and in travelling, the English language is becoming more and more important.

THE POST-CONGRESS TOUR IN THE BRITISH ISLES

For 16 days, between August 8 and 23, about one-third of the members of the Congress participated in a circular tour, so that there could be obtained as clear an idea as possible of the soils and the related geological and agricultural colleges and other organizations which are conducting research upon the soils of Britain. In addition to the work at Oxford and Cambridge Universities, we saw something of Harper Adams Agricultural College, University College, North Wales; Craigstone Farm of the North of Scotland Agricultural College and the Macauley Institute at Aberdeen. These various institutions are almost entirely the result of private initiative, with little or no government aid and no general coördination of activities, thus differing radically from the agricultural policy of the Philippines.

From Oxford, before the close of the Congress, two one-day trips had been taken, one to visit Rothamsted, the most important laboratory and estate (hacienda) in soil science; the second trip was to Jealott's Hill, where Imperial Chemical Industries is conducting excellent experimental work on pasture and other fertilizing problems, as well as upon the artificial curing of hay. This visit accentuated the importance of pasture management, and called attention to the striking differences in the relative proportions of different pasture plants, and the big differences in yield which can be obtained by properly regulating the pasturing intervals and the intensity of pasturing. Additional large differences result, and profitable returns are obtained from the application of suitable fertilizers.

The long tour from Oxford led through northwestern England, northern Wales, central, eastern, and northeastern Scotland, and down the eastern side of England to Cambridge. Travelling was sometimes by train, at other times by bus; the latter mode being always used for the circular tours of a day out into the country from the town which served as our local center for a day or so. These local trips were planned with great care by local students of the soils.

I am more than ever convinced that it would be to the great advantage of agricultural research in the Philippines if its researchers could travel widely and make repeated visits to study the agricultural research and progress in the surrounding countries, as well as for the Philippine Government to do much more in the way of sending scientists to attend all the important international congresses in their respective fields. Close confinement to office, laboratory, or class room has its merits, faithfulness is a virtue, but productive accomplishment for the advancement of agricultural science more often results when a scientist, with an *adequate* understanding of the conditions in his home country, meets his fellow workers in other countries: creative and profitable research more often results from the sparks which fly during personal conversation or conference discussion, and when a new point of view, a new perspective is obtained.

AMSTERDAM AND THE COLONIAL INSTITUTE

Holland is one of the countries which has endeavored to develop tropical agricultural science as much as possible; those of us who are acquainted with the astonishingly great strides made by agricultural science in the Netherlands Indies appreciate that. Yet in Holland and her colonies, as in Britain, it has been largely through the efforts of private associations, often without any financial aid from government, that the progress has been made. An expression of Holland's effort to foster the application of science to tropical lands and their peoples is the magnificent building of the Colonial Institute in Amsterdam, which serves as the home base for the study of tropical agricultural and other sciences. In the buildings of the Institute are housed an excellent library relating to the tropics, and a museum probably without an equal in its instructive display of tropical material on every phase of the Netherlands Indies' flora, fauna, and agricultural products and industries. In the Institute, too, are the offices of researchers retired from active duty in the colonies, where for the rest of their lives they can, surrounded by the best of facilities, continue their researches, and the shaping up and publication of material gathered during the more active years in the field. It was here that I found Professor Mohr, one of the most able students of tropical soils, hard at work on his latest book, one which will be unique as an authoritative study of tropical soils.

THE INTERNATIONAL INSTITUTE OF AGRICULTURE AT ROME

It was a pleasant duty for me on my return journey to Siam to call at this Institute on behalf of the government I represented. This gave me a chance to meet leading members of the staff, and to learn at first hand of the lines of work undertaken, and to better understand the place which the Institute occupies in world agriculture.

The Institute was established in 1905 through the efforts of David Lubin, of California, who had succeeded in interesting the King of Italy in the idea. The latter handsomely provided for the housing of the Institute and for a part of the support; a palatial and very useful central building was erected. This structure is now supplemented by two buildings: One is the library, one of the most modern structures for the purpose in Europe, and the other is the Calculation Division building. The Institute is now the instrument of 71 nations which have subscribed to the convention, and which now annually contribute each their proportionate share of the expenses. The Institute is thus a most representative international organization, uniting practically all countries without distinction of creed, color, religion, language or politics for the defense and advancement of the interests of agriculture throughout the world. It is thus an international authority capable of studying world agricultural conditions as a whole, of reporting from time to time upon the actual state of crops in the various countries, and of publishing such technical and economic information on agriculture in its various aspects as may be of general service to government and to the farming community.

It seems unnecessary to suggest that at the present juncture, with the changing status of the Philippine Government, that the new Commonwealth should certainly be a full member of the Institute, contributing its share of the support and submitting directly the agricultural data which are of such great importance for making as nearly complete as possible the world picture of the production and distribution of agricultural products.

In many ways these are days of rapid changes and great contrasts: five days from my departure from Rome, including a day spent among the ruins of Athens, I was at my desk in Bangkok. What extremes in cities! And in economic problems! And what visions of the past and questions as to the future flashed past the window during the rapid, almost violent translation from Occident to Orient!

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STUDIES ON SURRA: IV. VARIABILITY IN SIZE OF THE TRYPANOSOMES AND DENSITY OF INFECTION, NATURAL AND ACQUIRED IMMUNITY[1]

MIGUEL MANRESA AND B. M. GONZALEZ
Of the Department of Animal Husbandry

WITH THREE CHARTS

When this series of experiments on surra was begun it was feared that the problem would be long drawn out; consultation with people who had had more experience with the disease than we did not tend to lessen this fear. Much to our surprise, however, in less than two years of systematic and rather painstaking effort in the study of the disease, much headway has been made. The major objective of the work—elimination of the disease from the herds of oxen and water buffaloes belonging to the Department of Animal Husbandry—has been practically attained.

For over thirteen months now, not a single case of surra among the oxen has been added to those previously found, and among the water buffaloes no new case has been detected in the regular microscopical blood examination of the animals of the department for the last eight months. Moreover, there is not a single animal in the department at present, either ox or water buffalo, which had the infection as determined by either the complement-fixation test for surra or by actual presence of trypanosomes in the peripheral blood, that has not been found free from the infection by microscopical examination, by negative reaction to the complement-fixation tests or by animal inoculations, or by the three tests. It seems justifiable, therefore, to consider the present series of experiments as closed and to report a résumé of the work pertaining to spontaneous recovery.

THE PATHOGENIC MICROORGANISM

In fresh smears examined under low magnification the trypanosomes described in these experiments were invariably motile. The most conspicuous morphological characteristic of the organism under high magnification is the slender body with rather pointed ends, al-

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[1] Experiment Station contribution No. 1099. Received for publication on November 6, 1935.

though in preparations stained with Giemsa, variations in shape of both ends were noted. The flagellum appeared to be relatively short.

Early in these studies it seemed at times that the size of the trypanosome varied, being somewhat larger in the horse than in the ox, and at other times the size seemed to vary even in the blood of animals belonging to the same species. To settle this question, measurements were made from smears taken from an ox and from a water buffalo. After being dried in the air, the smears were dehydrated in absolute alcohol, stained with Giemsa,[2] washed in distilled water, and dried again in air. A sufficiently large number of camera lucida drawings were made under high magnification to render the data so obtained amenable to statistical treatment. The results are given in the following tabulation:

Observations on the length and width of trypanosomes obtained from cow No. 121, Caroline, and carabao No. 38, Mabait's Choice

SOURCE	MEANS (MICRONS)	STANDARD DEVIATION (MICRONS)	COEFFICIENT OF VARIABILITY (PER CENT)
Length of body including flagellum			
Cow No. 121	18.34 ± 0.183	2.17 ± 0.129	11.83 ± 0.705
Carabao No. 38	19.81 ± 0.172	2.04 ± 0.120	10.29 ± 0.610
Width of body taken at middle			
Cow No. 121	1.50 ± 0.015	0.18 ± 0.017	12.00 ± 0.715
Carabao No. 38	1.34 ± 0.010	0.15 ± 0.010	11.19 ± 0.670

It may be seen from the foregoing tabulation that in the water buffalo the trypanosomes are slightly longer but narrower than in the ox, the measurements being $19.81 \pm 0.172\ \mu \times 1.34 \pm 0.010\ \mu$ in the water buffalo, and $18.34 \pm 0.183\ \mu \times 1.50 \pm 0.015\ \mu$ in the ox. The differences, although small, were nevertheless significant. The coefficients of variation were about the same in both species of animals. These results appear to indicate that the host affected the size of trypanosomes. The data on measurements of trypanosomes in the rat and the horse bear this out. Rats were inoculated with infected blood from cow No. 121 and when the organisms appeared in the peripheral circulation of the rats they were inoculated into a horse. The data thus obtained are shown in the following tabulation:

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[2] In making the staining fluid 1 drop of 1 per cent potassium carbonate solution was added to 10 ml. of distilled water before the stain was mixed with it, as suggested by Burnett (1917).

Observations showing the length and width of trypanosomes as affected by passage from ox to rat and from rat to horse

SOURCE	MEANS (MICRONS)	STANDARD DEVIATION (MICRONS)	COEFFICIENT OF VARIABILITY (PER CENT)
Length of body including flagellum			
Ox	18.34 ± 0.183	2.17 ± 0.127	11.83 ± 0.705
Rat	25.60 ± 0.164	1.94 ± 0.115	7.57 ± 0.450
Horse	27.36 ± 0.160	1.91 ± 0.114	6.98 ± 0.416
Width of body taken at middle			
Ox	1.50 ± 0.015	0.18 ± 0.017	12.00 ± 0.715
Rat	1.35 ± 0.012	0.13 ± 0.011	9.62 ± 0.570
Horse	1.34 ± 0.010	0.15 ± 0.019	11.19 ± 0.670

That the size of the same species of trypanosome varies with the host is quite apparent from the data given in the foregoing tabulation. Laveran and Mesnil (1907) state that "*Trypanosoma evansi* measures, on the average, 25 μ in total length, by 1.50 μ in width, the free flagellum measuring 6 μ." In the Philippine trypanosomes the dimensions given by Novy, McNeal and Hare (1904) were 22 to 25 μ long and 1.5 to 1.7 μ wide. From study of stained preparations these workers concluded that "Philippine and Mauritian trypanosomes are quite unlike", it having been found by them that the Mauritian type of surra trypanosomes measured 33 μ long by 1.5 to 1.7 μ wide, that is, much larger than the Philippine type. From their studies on trypanosomes and trypanosomiasis Musgrave and Clegg (1903) concluded that "surra, nagana, mal de caderas, and probably dourine, were the same disease."

Finding marked differences in morphological characteristics between the parasites of the Indian and Mauritian surra, Laveran and Mesnil (1907) directed their inquiry into the relative virulence of the two types of trypanosomes and concluded that "the Mauritian surra is the same species as the Indian surra", although they differ in morphological characteristics. These data show how misleading it would be to establish diagnosis based largely on the size of the organism. It is evident that when passed from ox to rat, and then to horse the trypanosomes studied underwent a progressive change in size, and it would be of interest to determine whether the same organism, if passed back to the ox would revert to its original size. It would also be highly desirable to determine whether the size of a given strain of trypanosome has any relation to the virulence of the infection.

Chance observations on the number of trypanosomes in the peripheral circulation of different kinds of animals in the Department of Animal Husbandry disclosed the highest number in the water buffalo to be 16,667 per cu. mm. of blood, 92,000 per cu. mm. in the ox, and as high as 525,000 per cu. mm. has been observed in the horse. These casual observations indicating great variability in number, seem to bear a direct relation to the degree of susceptibility of the three kinds of animals. The usual observation confirmed by our own is that the horse is the most susceptible, the ox next and the carabao the least. In the rat inoculated with infected blood from water buffaloes the parasites multiply very rapidly. In one case counts made six days after inoculation showed the number of trypanosomes to be 25,000 per cu. mm., in a six-day period the number rose to 459,000 and one day later the count was 716,000 per cu. mm. The rat died shortly afterwards, indicating that the degree of concentration of infection bears a direct relation to the severity of the symptoms. Chart 1 shows the red blood cell counts, hemoglobin and the course of the infection in the rat inoculated.

In another case the trypanosome counts remained at about 8,000 per cu. mm. for a period of eight days, then suddenly the number rose to 492,000, death taking place a few hours afterwards. There were cases, however, in which the counts oscillated at fairly high figures, as for example, from 116,000 to 142,000 per cu. mm., the parasites disappearing entirely from the circulation for about three days, appearing again at fairly low figures, rising gradually but not exceeding 300,000 per cu. mm. on the day previous to death. The rates of multiplication of the organism in rats inoculated with infected blood from oxen follow curves similar to those inoculated with infected blood from water buffaloes. One case maintained the count at 41,000 per cu. mm. for 8 days but on the ninth day just before the rat died the number of trypanosomes rose to 475,000 per cu. mm. Another case remained at rather low levels for 8 days rising to only 108,000 just before death. Chart 2, showing the red blood cell counts, hemoglobin and the course of the trypanosome infection in a rat inoculated with infected blood from cow No. 121, is a typical curve of the many cases of rats inoculated with trypanosomes from cattle.

These findings are in agreement with those of Yutuc (1931). In studies on the resistance and the blood sugar of animals infected with surra trypanosomes (*Trypanosoma evansi*) Yutuc utilized white rats, guinea pigs, cats, dogs and horses. These were inoculated by him with *Trypanosoma evansi* which had been isolated from a horse. The charts reproduced in Yutuc's paper show very clearly that in the rat the course of the disease was very rapid, the trypanosome counts reaching their maximum of 650,000 per cu. mm. or even higher just before the death of the rat occurred. Yutuc states that the behavior of the strain of surra trypanosomes which he studied was in conformity with that reported by Kligler and Comaroff (1929).

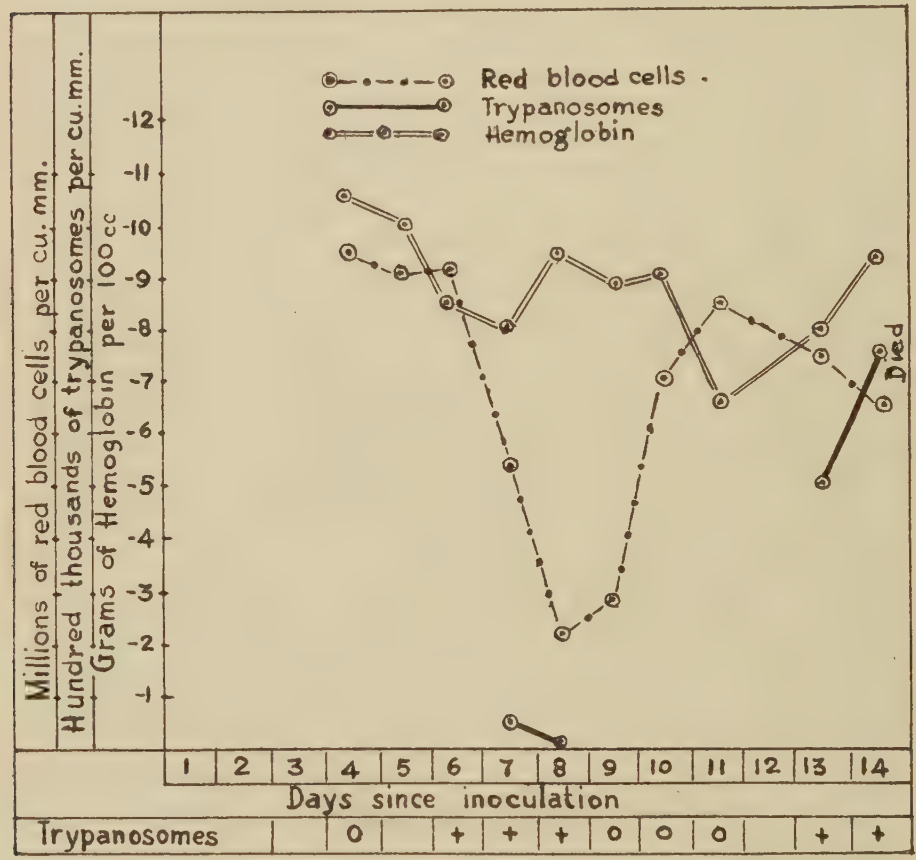

Chart 1.—Red blood cell counts, hemoglobin and the course of the infection in a rat inoculated with trypanosomes from a water buffalo.

SUSCEPTIBILITY OF OXEN AND WATER BUFFALOES

Laveran and Mesnil (1907) state that the relative susceptibility to surra of water buffaloes in India has been demonstrated by Lingard. In two water buffaloes which he inoculated with surra trypanosomes he found the incubation period to be 5 days, one animal having died 51 days and the other 125 days after inoculation. In oxen inoculated by Lingard with surra infected blood, it is reported that the parasites appeared in the peripheral circulation from the fourth to the tenth day after inoculation. This fact was taken as an indication of susceptibility to the disease.

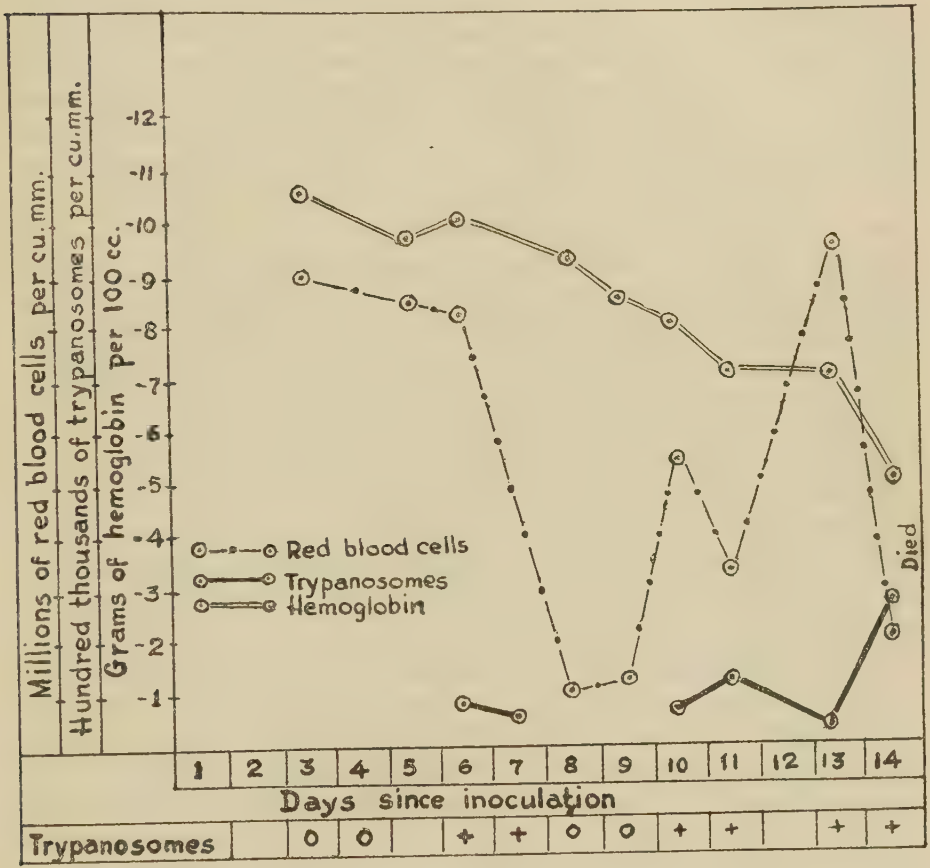

Chart 2.—Red blood cell counts, hemoglobin and the course of the infection in a rat inoculated with trypanosomes from a cow.

Early in the outbreak of surra in the College of Agriculture in 1933, complement-fixation tests were made of random samples of blood taken from 28 water buffaloes and 58 oxen. These tests showed the percentages of positive reaction for surra to be 60.34 for the oxen and 42.89 for the water buffaloes (Manresa, 1935), thus suggesting that the taurine species of cattle are more susceptible than the bubaline species. In the outbreak referred to in these experiments the percentages of mortality directly attributable to surra, computed on the total number of each kind of animal in the Department of Animal Husbandry found infected, were about 5 for the water buffaloes and 8 for the oxen, again indicating a higher percentage of mortality among oxen than the water buffaloes, assuming the same degree of exposure.

Both the acute and sub-acute manifestations of the disease have come under our observation. One hyper-acute case occurring in a Holstein-Friesian bull was reported in a previous paper (Manresa, 1935). Acute and sub-acute cases have been closely studied among animals that were quartered in our Isolation Barn protected from flies by wire screens. One of the acute cases which died in less than one month after the isolation of the organism in the bloodstream is here described. The subject was a Native bull, No. 158, named Tomas, aged 10 years. This animal reacted positively to the complement-fixation test for surra on January 26, 1934. Prior to that time four microscopical blood examinations were made on this animal at intervals of about ten days, but in none of these tests could the organism be found. In the period from January 26 to February 14, 1934 three more microscopical blood tests were made, all these tests proving to be negative. It was on February 20, 1934, when the trypanosomes were detected for the first time in the peripheral circulation. In accordance with our practice the bull was placed immediately in the Isolation Barn. The results of the observations made on this case are given in chart 3.

The data appearing in chart 3 show that in the acute case, as in the sub-acute cases, the trypanosomes recede from the peripheral circulation. The disappearance of the organism from the circulation is accompanied by a fall in temperature, thus confirming our previous report (Manresa, 1935) that fever occurs intermittently coinciding with the periods of paroxysms. Shortly before the outbreak of surra in the College in 1933, the animal under discussion was in excellent condition. The average red blood cell counts on this animal during a period of 18 months, from December, 1931 to

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[3] Animal No. 158 was one of the subjects used in the studies on the blood of four breeds and five crossbreeds of cattle with special reference to the adaptability of imported breeds to local conditions. The tests were performed by Mr. Nicomedes Reyes in the Department of Animal Husbandry from June, 1931 to June, 1933. The greater part of the data obtained in these studies was incorporated in a paper published in 1934 under the joint authorship of Manresa and Reyes.

May, 1933, inclusive, was 7,333,333 ± 51,301 per cu. mm.[3] During the same period the hemoglobin determinations averaged 9.77 ± 0.31 grams per 100 ml. of blood (Manresa and Reyes, 1934). Soon after infection the animal lost weight rather rapidly and on March 2, 1934 the red blood cell count was 5,000,000 per cu. mm. At that time the trypanosome enumeration was 45,000 per cu. mm. One week later, that is, on March 9, 1934, the red blood cells were reduced to 3,016,000 in number, and three hours later to 2,275,000. On that day the trypanosome enumeration was 91,667 per cu. mm. Eighteen determinations of hemoglobin indices made on different days from February 7 to March 9, 1934 gave the average of 5.41 ± 0.112 grams per 100 ml. of blood. During all this time the animal did not manifest any indication of digestive disturbances. The appetite was not greatly altered. The urine remained clear throughout.

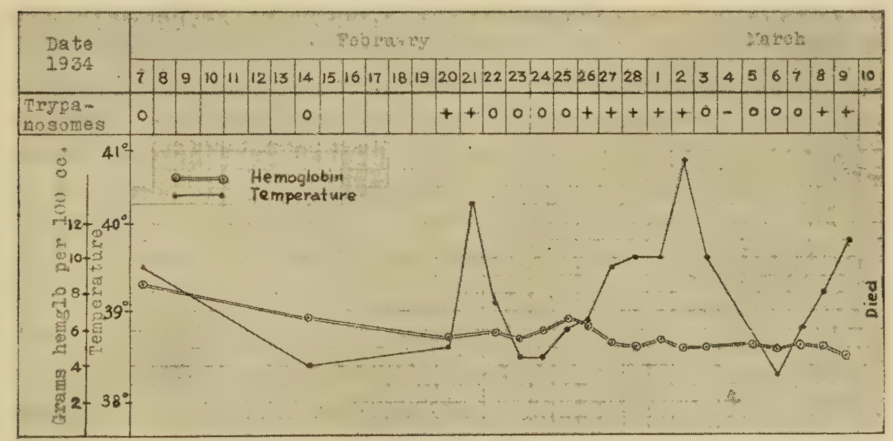

Chart 3.—Temperature and hemoglobin observations on Native bull No. 158, Tomas; age, 10 years, found infected with surra by the complement-fixation test on January 26, 1934, and by actual presence of trypanosomes in the bloodstream on February 20, 1934. Died on March 10, 1934.

Upon making the post-mortem examination the principal lesions found were the presence of fibrinous adhesions in the parietal wall and in the visceral organs in both the pleural and abdominal cavities. We have found this type of lesions to be rather characteristic in all the animals we have destroyed because of the surra infection as well as in those that died naturally. Smears taken from the heart of the animal 12 hours after death showed trypanosomes but close examination showed no sign of life.

ORGANS INVADED BY THE PARASITES

In all the animals that showed heavy infection at the time they were destroyed, smears were taken of practically all the important organs of the body in order to find in which ones the parasites are most numerous. Almost invariably the organisms could be seen in the blood smears taken from the heart, liver, spleen and lungs. In others the results were variable. Although many workers on surra believe that man is immune to the disease, so much so that Laveran and Mesnil (1907) state that, "the flesh of diseased surra cattle may, without danger, be used for the food of man, when the general condition of the animal is otherwise satisfactory," if the trypanosomes invade the lactiferous glands and contaminate the milk, it may not be safe to offer for sale any milk from surra infected cows. Also, such milk might conceivably serve as a means of disseminating the infection in a manner similar to the spread of the infection through the blood.

All our efforts, however, to detect the organism from smears taken from the tissues of the udder in such portions as were not stained with blood after incision, have failed to show any positive results. Neither have we found any trypanosomes in the milk of ten infected cows (eight regular and two carabao cows), some of which were definitely known to be heavily loaded with the organism, even after subjecting this milk to centrifuging for as long as 45 minutes at a revolution of about 2,000 per minute. In three of these cows the search was kept up every day for eleven days, and in one cow for eight days. The reaction to the complement-fixation of very young calves whose mothers were known to be infected with surra would settle the question as to whether or not infection is transmitted through the milk. Fifteen such calves were subjected to the test but only two of these were found positive. These two calves, however, were two months and fifteen months old, respectively, hence the infection could easily have been through other channels than by nursing from their dams. We have also examined numerous smears from the fetuses of surra positive mothers that were rather advanced in pregnancy at the time they were destroyed. In not one of the fetuses examined have we found any trypanosomes. It seems safe to state, therefore, that in surra *in utero* infection does not occur, and if very young calves are infected with the disease, channels other than milk must be looked for as the cause.

NATURAL RECOVERY FROM SURRA

In the second paper of this series (Manresa and Gonzalez, 1935) twenty-two cases of definite spontaneous recovery among oxen and water buffaloes were reported. Thirty-two additional cases have since been recorded, making the total number of recoveries to date, fifty-four. In the present paper these additional cases are listed as natural recovery cases numbered from 23 to 54, inclusive. Table 1 shows recovery cases numbers 23 to 33, inclusive. All the animals listed in the table were positive in the complement-fixation test on January 26, 1934. None of these oxen, however, ever showed any trypanosomes in the regular microscopical blood examinations made at intervals of about 7 to 10 days from January, 1934 to date, or within a period of about twenty-two months. Three cases, Nos. 30, 31, and 32 when tested by the complement-fixation test of July 30, 1934 were still positive for surra. Cases Nos. 30 and 33 reacted to the test with only one plus on December 13, 1934. Complement-fixation tests of all the animals listed in the table performed on February 19, 1935 gave uniformly negative results.

Table 2 shows natural recovery cases Nos. 34 to 41, inclusive. It may be seen in the table that cases Nos. 34, 35, and 36 actually showed the trypanosomes in the bloodstream, so the animals were placed in the Isolation Barn in accordance with our practice. The complement-fixation test on cases Nos. 34 and 35 on February 19, 1935 were negative. Rats inoculated with the blood of these animals on March 23 and May 13, 1935 failed to show any trypanosomes in the daily examination for as long as 61 days after inoculation. Case No. 36 showed positive reaction to the complement-fixation test for surra on January 26, 1934, but the trypanosomes were first detected in the peripheral circulation on August 8, 1934. From this date up to May 23, 1935, the organism followed the characteristic cycle, disappearing from the circulation but appearing again at fairly regular intervals until May 23, 1935, last date on which the organism could be found in the bloodstream. Daily microscopical blood examination for a period of five months after May 23, 1935 failed to disclose the presence of any trypanosomes. On June 18, 1935, three rats were inoculated intraperitoneally with 3 ml. each of the animal's blood. These rats showed no trypanosomes in the daily examination for as long as 62 days after inoculation. On July 31, 1935, three more rats were inoculated with the animal's blood. None of these rats showed any trypanosomes in the daily examination for a period of 35 days. At this writing all the inoculated rats are vigorous.

Cases Nos. 37 to 41, inclusive, had a similar history. They were all positive for surra by the complement-fixation test on January 26, 1934, but in not one of them could any trypanosome be found in the routinary microscopical blood examination during a period of one year and ten months. On July 3 and 6, 1935, rats were inoculated intraperitoneally with their blood, using three rats for each animal. None of the 15 rats thus inoculated showed any trypanosomes in the daily examination for a period of 51 days.

An additional list of natural recovery cases among the water buffaloes is given in table 3 which shows recovery cases Nos. 42 to 54, inclusive. The first five cases listed in the table; namely, Nos. 42, 43, 44, 45, and 46 have never shown any trypanosomes in the routinary blood examination during a period of 22 months from January, 1934. All these animals, however, were positive for surra in the complement-fixation test made on January 26, 1934. Cases Nos. 42 and 43 subsequently became negative for surra by the same test on February 19, 1935. The non-infectivity of the blood of cases Nos. 44, 45 and 46 was established by rat inoculation on July 1, 1935. Three rats for each animal were used, and large doses of blood were given but no trypanosomes could be found in the rats in the daily examination carried out for as long as 55 days after inoculation. Recovery cases Nos. 47 and 48 were found positive for surra in the complement-fixation test made later than January, 1934, but had histories similar to the three preceding cases. The non-infectivity of their blood was subsequently verified by animal inoculations, as may be seen in the table.

Cases Nos. 49 to 54, inclusive, represent the cases among the water buffaloes which were positive by both the complement-fixation tests and by actual presence of trypanosomes in the bloodstream. In accordance with the procedure of the experiments these animals were quartered in the Isolation Barn. Rats inoculated with the trypanosomes from these carabaos invariably died, indicating the virulence of the organism. In due time, however, all these water buffaloes got rid of the infection. The existence of recovery is definitely shown in cases Nos. 49 and 50 by the fact that on January 28, 1935, rats inoculated with the blood of these carabaos failed to show the infection, and the complement-fixation tests made on these carabaos on February 19, 1935 were negative. The non-infectivity of the blood of cases Nos. 51, 52, 53, and 54 was determined by negative results on rat inoculation tests, as may be seen in table 3.

In going over the available literature on the subject one is led to believe that recovery from surra infection, with complete sterilization of the blood, is an exception rather than the rule, the prevailing opinion among the workers being that the majority of the infected animals become permanent reservoirs of the infection, if they do not die. Few cases of definite recovery have been reported. Laveran and Mesnil (1907) cite the report of Edington and Coutts of two oxen in Mauritius which they observed to have "completely recovered". Lingard observed one case in an ox the blood of which he found no longer infective after 234 days. This observation is said to have been confirmed by Rogers in one case. We have found no experimental evidence of recovery reported by either Laveran and Mesnil or any other worker. The statements of recovery were presumably based on general observations which usually furnish the initial hypothesis upon which later experimental verification is necessary to establish them as scientific facts. We believe we have furnished such proof in these studies.

DURATION OF THE INFECTION

Complete histories of seven oxen and nine water buffaloes which were observed daily, and studies from the time the trypanosomes organisms were first detected in their peripheral circulation to the time of definite recovery as determined by complement-fixation tests and by animal inoculations reveal that periodical paroxysms are characteristic of the disease. In the oxen the periods of these paroxysms varied from 13 to 79 days, the average being 25.6 days. In the water buffaloes the periods varied from 11 to 53 days with an average at 24 days. In both the oxen and the water buffalo the shorter intervals were noted in the early stages of the disease, the intervals becoming somewhat farther apart in the later stages. In animals that recovered from the infection, the duration of the disease from the time infection was determined by actual presence of the parasites in the bloodstream to the approximate time recovery was definitely established by complement-fixation and animal inoculation tests varied from 31 to 304 days in the ox and from 24 to 321 days in the water buffalo. These observations apply to seven oxen and nine water buffaloes under close daily observation.

DIAGNOSTIC VALUE OF THE COMPLEMENT-FIXATION TEST

The complement-fixation method of diagnosis has been used for a number of diseases caused by trypanosomes by a number of investigators (Laveran and Mesnil, 1907). Mohler, Eichhorn, Brown, Pavlosvici, and others used this method of diagnosis with satisfactory results in dourine, a trypanosome disease of the horse caused by *Trypanosoma equiperdum* (Kolmer, 1924). Captain Kelser in 1927 first adopted complement-fixation tests for the diagnosis of surra. In a summary report of our work on surra published in the *American Veterinary Medical Association Journal* (Manresa and Gonzalez, 1935) the statement was made that, "we have never had a single case where an animal exhibiting the trypanosome organisms in the blood stream has tested negatively in the complement-fixation test." This statement still holds true and we may add that we have not had a single case reacting negatively to the complement-fixation test that caused trypanosome infection when laboratory animals were inoculated with its blood. It is apparent, therefore, that although the test is not specific for surra (Kelser, 1927), nevertheless the test has a definite practical value inasmuch as once trypanosome infection is known to exist, the identity of the organism as to species can be determined by its virulence in laboratory animals and by other tests. In any case, it seems necessary to check the tests by animal inoculations as it has been found that animals whose blood has proved sterile in rat inoculations may continue to give positive reaction to the complement-fixation test for as long as 22 to 143 days.

IMMUNITY IN SURRA

The occurrence of spontaneous recovery from surra having been definitely established, an investigation was conducted to determine whether or not immunity exists against further infection. The literature on this subject is very limited, what is more, the results of investigations conducted in other countries over thirty-two years ago lack confirmation in the Philippine field. Lingard's experiments carried out in India in 1893 "tended to prove that one attack from surra may grant immunity to the animal, at all events for a considerable period". However, two years later (1895) in a summary of further report on surra by the same worker the statement was made that "one attack does not render an animal immune to the disease". According to Laveran and Mesnil (1907), Edington and Coutts demonstrated in 1902 the existence of acquired immunity in an ox which they inoculated repeatedly with virulent blood. The ox had become immunized. Rats inoculated with blood of this ox did not become infected, whereas some months previously the blood of the ox produced infection in dogs.

In our investigation on this subject we have used oxen and water buffaloes that had recovered from natural infection as determined by their negative reaction to animal inoculations and the complement-fixation tests. The data obtained are given in table 4. The first case was cow No. 121, Caroline aged 9 years on April 29, 1935. The complete history has been published in previous papers (Manresa and Gonzalez, 1935). Recovery of this animal from surra was definitely established on December 13, 1934, and the animal had been discharged from the Isolation Barn, and had stayed out in the open field after recovery 172 days before it was drafted into the experiment on immunity. On April 29, 1935, five rats were inoculated intraperitoneally with the blood of this cow. These rats remained negative for trypanosomes in the daily microscopical examination of their blood throughout the entire period of the experiment, thus showing that natural re-infection had not occurred. On April 30, 1935, the cow was inoculated with 2 ml. of undiluted blood freshly drawn from the jugular vein of a surra infected horse. The trypanosome counts from samples of the horse's blood at the time of inoculation gave an average of 525,000 trypanosomes per cu. mm., so that the cow must have received not less than one billion trypanosomes. Six days later three rats were inoculated each with 3 ml. of the cow's blood. All these rats exhibited trypanosomes in the peripheral circulation and died of surra as recorded in table 4. In the period from May 6 to June 18, 1935, five different inoculations were made at weekly intervals, using three rats each time. Not one of the fifteen rats thus inoculated showed any trypanosomes in the daily microscopical examination of their blood for as long as 77 days, and none died during that period. The cow never showed any trypanosomes in the daily blood examination from April 30, to August 13, 1935. On September 24, 1935, the cow dropped a healthy looking calf, and at the writing of this paper both mother and calf are in the best of condition.

It is clear from the foregoing data that the myriads of trypanosomes injected into cow No. 121 had not multiplied in the system of this cow, and that some immunity had been acquired as a result of previous infection. Were the case otherwise, the organisms would have swarmed in the circulation, at least they could have been detected under the microscope or recovered in some of the fifteen rats inoculated after May 6, 1935, since it was shown by Topacio (1934) that a single trypanosome injected into susceptible animals is sufficient to cause lethal effects. That all the trypanosomes inoculated into the cow had died is quite apparent. But, the protective agents acquired by the cow seem to be ineffective in destroying the organisms within six days after inoculation, but succeeded in getting rid of them all between the sixth and the thirteenth day from the time of inoculation. These results may also be interpreted to mean that the trypanosomes injected into a cow that had recovered from surra may live as long as six to thirteen days.

The second case was a young Indian Nellore bull calf No. 68, Madras' Last, aged 1 year and 7 months on August 13, 1935. The recovery of this calf from surra was definitely established on February 19. 1935. For details on the history of the calf see table 2. The calf had been discharged from the Isolation Barn 165 days before being artificially inoculated with virulent trypanosomes. As in the former case, the sterility of the blood of this animal was established by rat inoculations. On August 13, 1935, the calf received about 1.5 ml. of blood heavily loaded with trypanosomes obtained from one rat that had been killed for the purpose. This amount of blood was all that could be drawn from the rat. On the 6th, 9th, and 13th days, and for two weeks after the 13th day of inoculation, rats were inoculated with the blood of the calf, using three rats at each inoculation. In this particular case none of the fifteen inoculated rats showed trypanosomes in the daily microscopical blood examinations for as long as 61 days after inoculation. All the rats gained weight steadily, and the female rats which were pregnant at the time of inoculation littered normally. Daily examination of the calf's blood from August 13 to this writing, or a period of 78 days, has failed to show any trypanosomes. The calf has gained weight progressively, and at present is in the pink of condition. The existence of active immunity cannot be doubted in this case.

The history of the water buffalo No. 36, named Sonia used in this experiment appears in table 3. This animal was 3 years old on August 13, 1935. This buffalo has undergone essentially the same treatment as calf No. 68, and stayed out of the Isolation Barn after its recovery from surra 194 days before it was drafted into the experiment. It may be seen in table 4 that the buffalo was inoculated with about 1.5 ml. of infected blood obtained from one rat that was infected with surra. On the 6th, 9th, and 13th days after inoculation, and for two weeks after the 13th day, rats were inoculated using three rats each time. None of the fifteen rats so inoculated nor the water buffalo ever showed any trypanosomes in the daily microscopical blood tests for as long as 61 days. At this writing the water buffalo and all the rats are in good condition.

It was our plan to carry out this investigation with more animals but unfortunately our stock of surra trypanosomes ran out, and no organism could be recovered from any of the animals of the Department of Animal Husbandry. At present there is not a single animal in the Department which previously was found infected as determined by the complement-fixation test and by animal inoculations which has not been proved negative for surra subsequently by these tests. The present data, however, are conclusive in showing that immunity has been conferred as a result of previous infection and it would be of great value to determine how long this acquired immunity would be effective.

Whether natural immunity is possessed by individuals can only be surmised from our observation on the animals in this department. Eleven animals, eight oxen and three water buffaloes, which seem to possess natural immunity to the disease, have come under our observation. These animals were continuously in contact with the surra infected animals but upon being tested repeatedly by the complement-fixation test, they continued to show negative reaction. Some evidences of the existence of natural immunity against surra in different breeds of cattle have been reported by workers outside of the Philippine field. Laveran and Mesnil (1907) mention that "Madoereesche oxen were attacked less often than the pure breed Javanese oxen and when attacked they were more resistant than the Javanese oxen". Crew (1928) states that the small humpless cattle of Nigeria show no evidences of ill-health when affected by trypanosomes, whereas the larger breed of humped cattle of tropical Africa fall easy victims to the scourge. It would appear that direct experimentation will undoubtedly settle this point. From the standpoint of practical value a study of the inheritance of resistance against trypanosomiasis should be undertaken.

SUMMARY AND CONCLUSIONS

1. A résumé of the experiments on surra carried out in the College of Agriculture from December, 1933 to October, 1935 is here given.

2. The sizes of the surra trypanosomes appear to be affected by the host, being $18.34 \pm 0.183\ \mu \times 1.50 \pm 0.015\ \mu$ in the ox and $19.81 \pm 0.172\ \mu \times 1.34 \pm 0.010\ \mu$ in the water buffalo. These differences in size of trypanosomes in the two species of animals are not great but significant when treated statistically.

3. Surra trypanosomes obtained from a cow and inoculated into a rat and then into a horse undergo further changes in size, being $25.60 \pm 0.164\,\mu \times 1.35 \pm 0.012\,\mu$ in the rat and $27.36 \pm 0.160\,\mu \times 1.34 \pm 0.010\,\mu$ in the horse. These results indicate that the different species of trypanosomes cannot be established solely on the basis of their size without regard to their hosts.

4. The number of trypanosomes found in the bloodstream appeared to bear a direct relation to the degree of susceptibility of the different kinds of animals, the horse being the most susceptible, the ox next and the water buffalo the least.

5. Intra-uterine infection was not found to occur in any of the cases that came under our observation. Of the fifteen calves from infected mothers, which calves were subjected to the complement-fixation tests, thirteen proved to be negative to the test, indicating that calves are not infected by surra by sucking from infected mothers. The two calves which showed positive reaction to the test were old enough and could have been infected through channels other than by nursing.

6. Fifty-four cases of definite recovery from surra were found in these studies. The criteria used in determining the existence of definite recovery were microscopical blood examination, complement-fixation test and animal inoculations. The duration of the infection from the time the trypanosome organism was first detected in the peripheral circulation to the approximate time when recovery was definitely established varied from 31 to 304 days in the oxen and from 24 to 321 days in the water buffaloes.

7. Cattle and water buffaloes recovering from surra possess active immunity which protects the animals from further infection. Casual observation on eight oxen and three water buffaloes which had not contracted the disease although they had been herded together continuously with animals that were positive to surra by the complement-fixation tests for as long as one year indicates the existence of natural individual immunity to the disease.

8. In oxen and water buffaloes surra can be controlled in a relatively short time by proper methods of management. The complement-fixation test is a useful aid in surra control, but the results obtained from these tests must be checked by animal inoculations.

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TABLE 1

Showing the results of subsequent complement-fixation tests for surra on oxen previously found positive for the disease by the same test

RECOVERY CASE	ANIMALS				DATE	RESULTS OF THE TESTS	COMPLEMENT-FIXATION TESTS MADE BY
	Name	No.	Blood composition	Age (years)			
23	Antifaz	185	Philamin	4	Jan. 26, '34 Feb. 19, '35	Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus.
24	Elisa	78	Philamin	11	Jan. 26, '34 Feb. 19, '35	Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus.
25	Fidel	157	Hereford-Nellore	5	Jan. 26, '34 Feb. 19, '35	Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus.
26	Bay	205	Philamin	3	Jan. 26, '34 Feb. 19, '35	Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus.
27	Fanny	220	Philamin	2	Jan. 26, '34 Feb. 19, '35	Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus.
28	Guadalupe	233	Philamin	2	Jan. 26, '34 Feb. 19, '35	Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus.
29	Nana	228	Holstein grade	2	Jan. 26, '34 Feb. 19, '35	Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus.
30	Ochoa	54	Indian Nellore	5	Jan. 26, '34 July 30, '34 Dec. 13, '34 Feb. 19, '35	Positive Positive one plus Negative	U.S. Army Med. Res. Board Bur. Animal Indus. Bur. Animal Indus. Bur. Animal Indus.
31	Shine	88	Philamin	10	Jan. 26, '34 July 30, '34 Feb. 19, '35	Positive Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus. Bur. Animal Indus.
32	Priscilla	96	Philamin	10	Jan. 26, '34 July 30, '34 Feb. 19, '35	Positive Positive Negative	U.S. Army Med. Res. Board Bur. Animal Indus. Bur. Animal Indus.
33	Rani	41	Indian Nellore	7	Jan. 26, '34 Dec. 13, '34 Feb. 19, '35	Positive one plus Negative	U.S. Army Med. Res. Board Bur. Animal Indus. Bur. Animal Indus.

TABLE 2

Showing the infected oxen which recovered spontaneously from surra as determined by subsequent tests

DATE	RESULTS OF TESTS			REMARKS
	Complement fixation	Microscopical examination	Animal inoculation	
RECOVERY CASE NO. 34: INDIAN NELLORE NO. 68; NAME, MADRAS LAST; PURE BREED; AGE, 6 MONTHS				
July 12, 1934		Positive		
July 19, 1934		Positive		
October 6, 1934		Positive		
February 19, 1935	Negative			Complement-fixation test by Bur. Animal Indus.
March 23, 1935			Three rats were each inoculated with 3 ml. of the animal's blood	These rats showed no trypanosomes in the daily blood examination up to June 17, 1935, nor after that date
RECOVERY CASE NO. 35: INDIAN NELLORE NO. 46; NAME, NESTOR; PURE BREED; AGE, 5 YEARS				
July 23, 1934		Positive		
July 24, 1934			A white rat was inoculated with 2 ml. of the animal's blood	The rat was infected with trypanosomes and died
February 19, 1935		Negative under the microscope from July 23		
	Negative			Complement-fixation test by Bur. Animal Indus.
March 23, 1935			A white rat was inoculated with 4 ml. of the animal's blood	This rat showed no trypanosomes in the daily examination, but died before time enough to exclude possibility of infection

TABLE 2 (Continued)

RECOVERY CASE NO. 36: INDIAN NELLORE COW NO. 35; NAME, ROSAL: PURE BREED; AGE, 9 YEARS

January 26, 1934	Positive			Complement-fixation test by the U.S. Army Med. Res. Board
July 30, 1934	Positive			Complement-fixation test by the Bur. Animal Indus.
August 8, 1934		Positive		All the smears taken in the morning and afternoon showed trypanosomes
		The animal was placed in the Isolation Barn which is screened excluding flies. Daily microscopical blood examination started on Aug. 8, 1934, and the organisms were detected in the circulation of the cow on the following dates: Aug. 9 and 27; Sept. 11; Oct. 8 and 22; Nov. 6, 22, and 23, 1934; January 11, 24, 25; February 8; March 8; April 5, May 21, 22, 23, 1935		
May 20, 1935			Two rats were each inoculated intraperitoneally with 2 ml. of the animal's blood	Both rats showed the trypanosome organisms in the peripheral circulation 7 days after inoculation. One rat died on June 2, the other on June 5, 1935
June 18, 1935			Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	None of these rats showed any trypanosomes in the daily microscopical blood examination from June 16 to Aug. 10, 1935. All the rats gained weight steadily and when discarded from the experiments on Aug. 19, 1935 they were all vigorous
		Negative in the daily blood examinations from August 8, 1934 to the writing of this paper		
July 31, 1935			Three rats were each inoculated with 3 ml. of the cow's blood	None of these rats showed any trypanosomes in daily microscopical blood examination from July 28 to Aug. 27, 1935. All the rats gained weight
September 2, 1935				The cow was released from the Isolation Barn.

TABLE 2 (Continued)

RECOVERY CASE No. 37: COW No. 193; NAME, SOPHIE; BLOOD COMPOSITION; HOLSTEIN GRADE; AGE, 4 YEARS				
January 26, 1934	Positive			Complement-fixation test by U.S. Army Med. Res. Board
January 26, 1934		Never showed any trypanosomes in the routinary blood examination from Jan., 1934 to this writing		
July 3, 1935			Three rats were each inoculated with 3 ml. of the cow's blood	None of these rats showed any trypanosomes in the daily blood examination for as long as 48 days after inoculation
RECOVERY CASE NO. 38: STEER NO. 168; NAME, RAFAEL; BLOOD COMPOSITION; NELLORE-NATIVE; AGE, 5 YEARS				
September 20, 1934	Positive			Complement-fixation test by the Bur. Animal Indus.
		Never showed any trypanosomes in the routinary blood examination from Jan., 1934 to this writing		
July 3, 1935			Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	No trypanosomes were found in the peripheral circulation in any of these rats for as long as 51 days after inoculation
RECOVERY CASE No. 39: COW No. 62; NAME, GUMAMELA; PHILAMIN BREED; AGE, 11 YEARS AND 9 MONTHS				
January 26, 1934	Positive			Complement-fixation test by U.S. Army Med. Res. Board
		Never showed any trypanosomes in the routinary blood examination from Jan., 1934 to this writing		
July 3, 1935			Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	No trypanosomes were found in the peripheral circulation in any of these rats for as long as 48 days after inoculation

TABLE 2 (Continued)

RECOVERY CASE NO. 40: COW NO. 90; NAME, SAMPAGA; PHILIPPINE NATIVE; AGE, VERY OLD				
January 26, 1934	Positive			Complement-fixation test by U.S. Army Med. Res. Board
July 30, 1934 November 8, 1934	Positive Positive with 2 plus			Complement-fixation test by the Bur. Animal Indus.
		Negative in routinary blood examination from Jan., 1934 to this writing		
July 6, 1935			Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	None of these rats showed any trypanosomes in the daily blood examination from July 5, to Aug. 21, 1935. When the rats were discarded from the experiments on Sept. 3, 1935 they were vigorous
RECOVERY CASE NO. 41: CALF NO. 236; NAME, FELIX; BLOOD COMPOSITION, HOLSTEIN-NELLORE; AGE, 1 YEAR				
January 26, 1934	Positive			Complement-fixation test by U.S. Army Med. Res. Board
		Never showed any trypanosomes in the routinary blood examination from Jan., 1934 to this writing		
July 6, 1935			Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	None of these rats showed any trypanosomes in the daily blood examinations from July 5 to Aug. 21, 1935. When the rats were discarded from the experiments on Sept. 3, 1935, they were all vigorous

TABLE 3

Showing the surra infected water buffaloes which became negative in the subsequent tests by animal inoculations and complement-fixation

DATE	RESULTS OF TESTS			REMARKS
	Complement-fixation	Microscopical examination	Animal inoculations	
RECOVERY CASE NO. 42: INDIAN BUFFALO BULL, NO. 21; NAME, ABIJAH; AGE, 6 YEARS, 3 MONTHS				
January 26, 1934	Positive			Complement-fixation test by the U.S. Army Med. Res. Board
		This animal showed no trypanosomes in the routinary micdoscopical blood examinations		These examinations were made at intervals of from 7 to 10 days from January, 1934 to this writing, October, 1935
February 19, 1935	Negative			Complement-fixation test by the Bur. Animal Indus.
RECOVERY CASE NO. 43: INDIAN BUFFALO COW, NO. 11; NAME, INDIAN BEAUTY; AGE, 12 YEARS				
January 26, 1934	Positive			Complement-fixation test by the U.S. Army Med. Res. Board
		This animal showed no trypanosomes in the routinary microscopical blood examinations		The examinations were made at intervals of from 7 to 10 days from Jan., 1934 to this writing, Oct., 1935
February 19, 1935	Negative			Complement-fixation test by the Bur. Animal Indus.
RECOVERY CASE NO. 44: INDIAN BUFFALO COW, NO. 15; NAME, IRIS; AGE, 9 YEARS				
January 26, 1934	Positive			Complement-fixation test by the U.S. Army Med. Res. Board
		Showed no trypanosomes in the routinary blood examination from Jan., 1934 to this writing		
July 1, 1935			Three rats were each inoculated with 3 ml. of the carabao's blood	Daily microscopical blood examination for 55 days failed to show any trypanosomes. When the rats were discarded from the experiments on Aug. 26, 1935 they were in good condition

TABLE 3 (Continued)

RECOVERY CASE NO. 45: NATIVE CARABAO-INDIAN CROSSBREED, NO. 59; NAME, AMY; AGE, 7 YEARS				
January 26, 1934	Positive			Complement-fixation test by the U.S. Army Med. Res. Board
		Showed no trypanosomes in the routinary blood examination from Jan., 1934 to this writing		
July 1, 1935			Three rats were each inoculated with 3 ml. of the carabao's blood	Daily microscopical blood examination for 55 days failed to show any trypanosomes. The rats were discarded from the experiments on Aug. 26, 1935
RECOVERY CASE NO. 46: PHILIPPINE NATIVE CARABAO, NO. 64; NAME, LAWAAN; AGE, 7.5 YEARS				
January 26, 1934	Positive			Complement-fixation test by the U.S. Army Med. Res. Board
		Showed no trypanosomes in the routinary blood examination from Jan., 1934 to this writing		
July 1, 1935			Three rats were each inoculated with 3 ml. of the animal's blood	Daily microscopical blood examination for 55 days failed to show any trypanosomes. The rats were discarded from the experiments on August 26, 1935
RECOVERY CASE NO. 47: INDIAN BUFFALO COW, NO. 10; NAME, MISS MAQUILING; AGE, 12 YEARS				
January 26, 1934	Negative			Complement-fixation test by the U.S. Army Med. Res. Board
April 12, 1934	Positive			Complement-fixation test by the U.S. Army Med. Res. Board
February 19, 1935	Positive			Complement-fixation test by the Bur. Animal Indus.
		Never showed any trypanosomes in weekly examination from Jan., 1934 to Feb., 1935		From Feb. 19, 1935, examinations under the microscope were made every day, but no trypanosomes were found
March 23, 1935			Two rats were each inoculated with 3 ml. of the carabao's blood	On May 4, 1935 or 42 days after inoculation the rats were still negative

TABLE 3 (Continued)

RECOVERY CASE NO. 48: INDIAN BUFFALO BULL NO. 33; NAME, NORTH; AGE, 2 YEARS				
September 20, 1934	Positive			Complement-fixation test by the Bur. Animal Indus.
November 8, 1934	Positive			Complement-fixation test by the Bur. Animal Indus.
		Showed no trypanosomes in weekly blood examination from Jan., 1934 to date		
March 23, 1935			Two rats were each inoculated intraperitoneally with 3 ml. of the carabao's blood	On May 4, 1935 or 42 days after inoculation the blood of rats was still negative under the microscope
RECOVERY CASE NO. 49: INDIAN BUFFALO HEIFER NO. 36; NAME, SONIA; AGE, 1 YEAR, 3 MONTHS				
January 26, 1934	Positive			Complement-fixation test by the U.S. Army Med. Res. Board
March 14, 1934			A rat was inoculated with 3 ml. of the animal's blood	Trypanosomes were present in the peripheral circulation 6 days after inoculation
June 21, 1934		Positive		Several trypanosomes seen
November 8, 1934	Positive			With 3 plus. Complement-fixation test was made by the Bur. Animal Indus.
January 28, 1935			Rat was inoculated with 2.5 ml. intraperitoneally	Rat still negative on April 6, in the daily microscopic blood examination 68 days after inoculation
February 19, 1935	Negative			Complement-fixation test by the Bur. Animal Indus.
				Daily examination of the blood of the carabao from June 22, 1934 to Jan. 12, 1935 showed it was negative for trypanosomes. After Jan. 12, 1935, examinations were made every week and up to March 19, failed to show any trypanosome organisms

TABLE 3 (Continued)

RECOVERY CASE NO. 50: CARABAO NO. 44; NAME, JANE: BLOOD COMPOSITION, INDIAN BUFFALO-NATIVE: AGE, 8 YEARS				
January 26, 1934	Negative			Complement-fixation test by the U.S. Army Res. Board
April 21-26, 1934		Positive		
May 1-2, 1934		Positive		
June 25, 1934		Positive		
July 4-6, 1934		Positive		
July 25-26, 1934		Positive		
August 10, 1934		Positive		
January 28, 1935	Negative		Rat inoculated with 3 ml. blood	Rat still negative on April 6, in daily microscopic blood examination i.e. 68 days after inoculation
February 19, 1935	Negative			Complement-fixation test by the Bur. Animal Indus.
RECOVERY CASE NO. 51: CARABAO NO. 9; NAME, MABAIT: BLOOD COMPOSITION, NATIVE: AGE, 17 YEARS, 5 MONTHS				
January 26, 1934	Negative			Complement-fixation test by the U.S. Army Med. Res. Board
July 30, 1934	Positive			Complement-fixation test by the Bur. Animal Indus.
Dec. 24, 1935		Positive		
January 28, 1935			Rat inoculated with 2 ml. Positive for trypanosome on Feb. 2, 1935	Died on Feb. 12, 1935
March 23, 1935			Rat inoculated with 3 ml. Showed no trypanosomes in daily microscopic blood examination for 50 days and was living on June 21, 1935	
May 13, 1935			Two rats were each inoculated with 2 ml.	These rats showed no trypanosomes in the daily blood examination for 59 days. On July 23, when the rats were discarded from the experiments they were vigorous

TABLE 3 (Continued)

RECOVERY CASE NO. 52: CARABAO NO. 38; BLOOD COMPOSITION, GRADE INDIAN BUFFALO-NATIVE; AGE, 10 YEARS				
January 26, 1934	Positive			
Feb. 21-28, 1934		Positive		Continuously positive for 7 days
March 14, 1934			Rat inoculated with 1 ml. of blood. Positive on the 6th day after inoculation	Died on the 16th day after inoculation
April 16, 1934		Positive		Numerous trypanosomes were seen
September 28, 1934			Rat inoculated with 4 ml. of blood. Positive on the 6th day after inoculation	Died on the 14th day after inoculation
December 28, 1934			Rat inoculated with 2.5 ml. of blood	Negative in the daily examination for 52 days. But died of severe parasitic infestation (fleese)
December 13, 1934	2 plus			Complement-fixation test by the Bur. Animal Indus.
December 28, 1934			Rat inoculated with 3 ml. of blood	Negative in the daily microscopic blood examination for 44 days. Rat died of fleese infestation
February 19, 1935	Anti-complementary			Complement-fixation test by the Bur. Animal Indus.
March 23, 1935			Three rats were each inoculated intraperitoneally with 2.5 ml. of the animal's blood	These rats never showed any trypanosomes in the daily blood examinations for 59 days
		Daily microscopical blood examination of the carabao's blood from February 21, 1934 to April 8, 1935 failed to show the presence of trypanosomes		

TABLE 3 (Continued)

RECOVERY CASE NO. 53: NATIVE CARABAO NO. 39; NAME, MAMERTA; AGE, 9 YEARS, 7 MONTHS

January 26, 1934	Negative			Complement-fixation test by the U.S. Army Med. Res. Board
July 30, 1934	Negative			Complement-fixation test by the Bur. Animal Indus.
November 1-3, 1934		Positive		Positive for 3 days
Dec. 13, 22, 26, 1934		Positive		
Jan. 3, 16, 18, 1935		Positive		
Mar. 6, 7, 22, 1935		Positive		
April 2-3, 1935		Positive		
May 20, 1935			Two rats were each inoculated with 2 ml. of the animal's blood	Both rats showed trypanosomes in the peripheral circulation 6 days after inoculation. One rat died on the 14th, the other on the 16th day after inoculation
June 12, 1935			Three rats were each inoculated with 3 ml. of the animal's blood	All these rats became positive and two died on the 13th, one on the 20th day after inoculation
July 31, 1935			Three rats were each inoculated with 3 ml. of the animal's blood	Two of these rats became positive for trypanosomes and died on the 16th day after inoculation. One showed no trypanosomes in the daily examination for 56 days
		The trypanosomes were not detected in the peripheral circulation of the carabao from April 3, 1935 to the writing of this paper, Oct. 1935		
September 18, 1935			Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	Daily microscopical blood examination for a period of 38 days failed to show any trypanosomes At this writing, Oct. 30, 1935 the rats are all in good condition

TABLE 3 (Continued)

RECOVERY CASE NO. 54: CARABAO NO. 88, NAME, DEMETRIA; BLOOD COMPOSITION, INDIAN BUFFALO-NATIVE; AGE, 8 YEARS, 10 MONTHS				
January 26, 1934	Negative			Complement-fixation test by the U.S. Army Med. Res. Board
July 30, 1934	Negative			Complement-fixation test by the Bur. Animal Indus.
February 28, 1935		Positive		
April 2, 1935		Positive		
May 20, 1935			Two rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	Both rats showed trypanosomes in the peripheral circulation 6 days after inoculation and died
May 20, 1935			Three rats were each inoculated with 3 ml. of the animal's blood	The trypanosomes were visible in the bloodstream of the rats 4 days after inoculation. One rat died 8 days after inoculation, another, 14 days after, and the third rat, 18 days after
		From April 2, 1935 to the writing of this paper, Oct. 1935, no trypanosomes were seen in the daily microscopical blood examination of the carabao		
July 31, 1935			Three rats were each inoculated with 3 ml. of the carabao's blood	These rats showed no trypanosomes in the daily blood examinations for 43 days. When discarded the rats were vigorous
September 18, 1935			Three rats were each inoculated with 3 ml. of the carabao's blood	These rats showed no trypanosomes in the routinary daily examinations carried out to the end of the experiments

TABLE 4

Showing the reaction of animals which had recovered spontaneously from surra infection to subsequent infection artificially induced by inoculations with virulent trypanosome organism.

ANIMAL: COW NO. 121; NAME, CAROLINE; BLOOD COMPOSITION, GRADE HEREFORD; AGE, 9 YEARS ON APRIL 29, 1935.

History: This cow was found infected with surra by actual presence of *Trypanosoma evansi* organisms in the peripheral blood, by positive reaction to the complement-fixation tests for surra, and by animal inoculations. The existence of definite recovery from surra was established by the same criteria; namely, continued negative blood examination, failure to kill rats and horse which were inoculated with the animal's blood, and negative reaction to the complement-fixation test for surra on December 3, 1934.

DATE 1935		MICROSCOPICAL BLOOD EXAMINATION	ANIMAL INOCULATIONS	RESULTS
April	29	Negative	Five rats were each inoculated with 3 ml. of the cow's blood	These five rats remained negative for trypanosomes in the daily microscopical blood examinations from May 2 to June 24, 1935. From June 26, 1935, microscopical blood examinations were continued every other day up to July 13, 1935; all examinations gave negative results
	30	Negative	The cow was inoculated with 2 ml. of undiluted blood freshly drawn from a horse infected with surra. Trypanosome counts from samples of the horse's blood at the time of inoculation gave an average of 525,000 per cu. mm. The horse died of surra on May 1, 1935	
May	1	Negative		
	2	Negative		
	3	Negative		
	4	Negative		
	5	(Sunday)		
	6	Negative	Three rats were each inoculated with 3 ml. of the cow's blood	Two of these three rats exhibited the trypanosome organisms in the peripheral blood 11 days after inoculation, the third rat, 12 days after. One rat died on the 15th day after inoculation, another, on the 16th day; and the third, on the 20th day
	7	Negative		
	8	Negative		
	9	Negative		
	10	Negative		
	11	Negative		
	12	(Sunday)		
	13	Negative	Three rats were each inoculated with 3 ml. of the cow's blood	These three rats remained negative for trypanosomes in the daily microscopical blood examination from May 16 to June 3, 1935. From June 5 examinations were continued every other day up to July 13, 1935; these examinations failed to show the organisms

TABLE 4 (Continued)

	14	Negative		
	15	Negative		
	16	Negative		
	17	Negative		
	18	Negative		
	19	(Sunday)		
	20	Negative	Three rats were each inoculated with 3 ml. of the cow's blood	These rats failed to show any trypanosome organisms in the daily microscopical blood examinations or in the examinations made every other day; when discarded from the experiments on August 10, 1935, that is, 82 days after inoculation, the rats were all in good condition, and had gained in weight steadily
	21	Negative		
	22	Negative		
	23	Negative		
	24	Negative		
	25	Negative		
	26	(Sunday)		
	27	Negative	Three rats were each inoculated with 3 ml. of the cow's blood	These rats failed to show any trypanosomes in the daily microscopical blood examinations nor in the examinations made every other day; when discarded from the experiments on August 10, 1935; that is, 77 days after inoculation, they were in good condition, and had gained in weight steadily
	28	Negative		
	29	Negative		
	30	Negative		
	31	Negative		
June	1	Negative		
	2	(Sunday)		
	3	Negative	Three rats were each inoculated with 3 ml. of the cow's blood	These rats failed to show any trypanosomes in the daily microscopical blood examinations nor in the examinations made every other day; when discarded from the experiments on August 10, 1935, that is, 68 days after inoculation, they were in good condition, and had gained in weight steadily

TABLE 4 (Continued)

4	Negative		
5	Negative		
6	Negative		
7	Negative		
8	Negative		
9	(Sunday)		
10	Negative		
11	Negative		
12	Negative		
13	Negative		
14	Negative		
15	Negative		
16	(Sunday)		
17	Negative		
18	Negative	Three rats were each inoculated with 3 ml. of the cow's blood	These rats failed to show any trypanosomes in the daily microscopical blood examinations nor in the examinations made every other day; when discarded from the experiments on August 10, 1935, that is, 53 days after inoculation, they were in good condition, and had gained in weight steadily
19	Negative		
20	Negative		
21	Negative		
22	Negative		
23	(Sunday)		
24	Negative		
25	Negative		
26	Negative		Daily examination of the cow's blood was continued to August 13, 1935. All examinations having proved negative the cow was released from the Isolation Barn on August 14, 1935 to make room in the Barn for other animals to be subjected to similar experiment
27	Negative		
28	Negative		
29	Negative		

ANIMAL: OX NO. 68; NAME, MADRAS LAST; BLOOD COMPOSITION, PURE INDIAN NELLORE; AGE, 1 YEAR AND 7 MONTHS ON AUG. 13, 1935

History: The infection with surra in this animal was determined by actual presence of *Trypanosoma evansi* organisms in the peripheral circulation, by the positive reaction to the complement-fixation tests for surra, and by animal inoculations. The existence of definite recovery from the disease was established by the same criteria; namely, continued microscopical blood examinations, failure of the animal's blood to kill laboratory animals, and by the negative reaction to the complement-fixation test. Records show that this animal was released from the Isolation Barn on March 1, 1935

DATE 1935	MICROSCOPICAL BLOOD EXAMINATION	ANIMAL INOCULATIONS	RESULTS
August 13	Negative	Three rats were each inoculated with 2 ml. of the animal's blood	These rats were all negative in the daily microscopical blood tests from Aug. 16 to Sept. 14, 1935. On Oct. 19, 1935 two of the rats were living and vigorous. One died on Oct. 18, 1935 and post-mortem examination showed parasitic lesions in the liver. These rats served as check to eliminate the possibility of re-infection after recovery of the animal
August 13		The animal was inoculated with infected blood from a rat heavily infected with trypanosomes. About 1.5 ml. was used, this being the amount of blood that could be obtained from the rat	

TABLE 4 (Continued)

August	14	Negative	Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	All these rats were negative in the daily microscopical blood examination from Aug. 22 to Sept. 21, 1935. All were living and vigorous on Oct. 19, 1935
	15	Negative		
	16	Negative		
	17	Negative		
	18	(Sunday)		
	19	Negative		
August	20	Negative	Three more rats were each inoculated intraperitoneally with the animal's blood	All these rats were negative in the daily blood examination from Aug. 26 to Oct. 5, 1935. On Oct. 19, 1935 the rats were living and vigorous
	21	Negative		
	22	Negative		
August	23	Negative	Three rats were each inoculated intraperitoneally with 2 ml. of the animal's blood	None of the rats showed any trypanosomes in the daily microscopical blood examinations from Aug. 29 to Oct. 5, 1935. On Oct. 19, 1935 these rats were vigorous. Two females which were pregnant at the time of inoculation littered normally, one on Sept. 28, 1935 with 10 young, the other on Oct. 10, 1935 with 8 young
	24	Negative		
	25	(Sunday)		
	26	Negative		
August	27	Negative	Three rats were each inoculated with 3 ml.	None of these rats showed any trypanosomes in the daily microscopical blood examinations from Sept. 6 to Oct. 5, 1935. One of the rats littered normally on Sept. 19, 1935
	28	Negative		
	30	Negative		
	31	Negative		
September	1	(Sunday)		
	2			
September	3	Negative	Three rats were each inoculated intraperitoneally with 3 ml.	These rats never showed any trypanosomes in daily microscopical blood examinations from Sept. 12 to Oct. 18, 1935. At this writing the rats are vigorous
	4	Negative		
	5	Negative		
September	6	Negative		
	7	Negative		
	8	(Sunday)		
	9	Negative		
September	10	Negative		Daily examination of the animal's blood was continued to October 31, 1935. All examinations were negative. The animal was released from the Isolation Barn on Oct. 31, 1935
	11	Negative		
	12	Negative		
	13	Negative		
	14	Negative		
	15	(Sunday)		
	16	Negative		

TABLE 4 (Continued)

ANIMAL: CARABAO, NO. 36; NAME, SONIA; BLOOD COMPOSITION, PURE INDIAN BUFFALO, AGE, 3 YEARS

History: The infection with surra in this animal was determined by actual presence of *Trypanosoma evansi* organisms in the peripheral circulation, by the positive reaction to the complement-fixation tests for surra, and by animal inoculations. The existence of definite recovery from the disease was established by the same criteria; namely, continued microscopical blood examinations, failure of the animal's blood to kill laboratory animals, and by the negative reaction to the complement-fixation test. Records show that this animal was released from the Isolation Barn on January 31, 1935.

DATE 1935		MICROSCOPICAL BLOOD EXAMINATION	ANIMAL INOCULATIONS	REMARKS
August	13	Negative	Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	These rats served as control to eliminate the possibility of re-infection occurring after the animal was discharged from the Isolation Barn. All daily examinations of the blood of the rats under the microscope from Aug. 16 to Sept. 28, 1935 proved to be negative for trypanosomes. On Oct. 19, 1935 all the rats were vigorous
August	13		The animal was then inoculated with about 1.5 ml. of infected blood from a rat whose blood was loaded with trypanosomes. This was all the blood that could be obtained from one rat	
August	14	Negative		
	15	Negative		
	16	Negative		
	17	Negative		
	18	(Sunday)		
	19	Negative	Three rats were each inoculated with 3 ml. of the animal's blood	All these rats were negative in the daily microscopical blood examinations from Aug. 22 to Sept. 21, 1935 and all were vigorous on Oct. 19, 1935
August	20	Negative		
	21	Negative		
	22	Negative	Three more rats were each inoculated with 3 ml. of the animal's blood	None of these rats showed any trypanosomes in the daily examination from Aug. 26 to Sept. 28, 1935. All were vigorous on Oct. 19, 1935

TABLE 4 (Continued)

August	23	Negative		
	24	Negative		
	25	(Sunday)		
August	26	Negative	Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	Daily examination of the rats' blood under the microscope from Aug. 29 to Oct. 5, 1935 failed to show any trypanosomes. All the rats were living on Oct. 19, 1935. One female rat which was pregnant at the time of inoculation littered normally with 8 young
August	27	Negative		
	28	Negative		
	29	Negative		
	30	Negative		
	31	Negative		
September	1	(Sunday)		
	2	Negative	Three rats were each inoculated intraperitoneally with 3 ml. of the animal's blood	None of these rats ever showed trypanosomes in the daily microscopical blood examinations from Sept. 6 to Oct. 5, 1935. All the rats were living on Oct. 19, 1935
September	3	Negative		
	4	Negative		
	5	Negative		
	6	Negative		
	7	Negative		
	8	(Sunday)		
	9	Negative	Three more rats were each inoculated with 3 ml. of the animal's blood	These rats were all negative in the microscopical blood examinations conducted every day from Sept. 13 to Oct. 18, 1935
September	10	Negative		
	11	Negative		
	12	Negative		
	13	Negative		
	14	Negative		
	15	(Sunday)		
	16	Negative		Daily microscopical examination of the blood of the Indian Buffalo was continued to Oct. 31, 1935. All examinations failed to show any trypanosomes. The animal was released from the Isolation Barn on Oct. 31, 1935

CONSTRUCTION OF MUSHROOM BEDS IN THE CANTON REGION [1]

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WITH EIGHT TEXT FIGURES

During the summer vacation of 1935, I was detailed to Lingnan University in Canton, China as Exchange Professor of Plant Physiology. While in that country I had the opportunity of observing,[2] among other things, a method of establishing mushroom beds on farms in or near the university campus. As is well known, mushrooms are a very popular article of food in China and are grown extensively. In the Philippines, mushrooms are also highly prized as food but as they are not grown extensively they are not widely used or popular. For, although conditions in this country are favorable to the successful raising of these edible fungi, there seems to be a lack of interest in this industry. As a matter of fact, this paper was written with the hope that it might help to arouse interest in raising mushrooms as a home industry and on a business scale in the Philippines.

The mushroom beds in the Canton region are built on the farmstead or in the fields, usually in rotation with crops of rice. They are exposed to the sun and appear to be differently constructed from the so called English type or the French type, which are employed in

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NOTE: By an unusual coincidence two papers on mushroom culture in the Canton region reached us the same week. One was written by one of our former students now on the staff of Lingnan University and the other by one of our faculty who was Exchange Professor in the same university last summer. Neither knew of the other's intention of writing on the subject of mushrooms. As the papers did not repeat material and believing the information in each to be not only of interest but of much practical value we decided to publish both. Mr. Benemerito's paper appeared in the January issue of this journal.—EDITOR.

[1] Experiment Station contribution No. 1100. Received for publication November 12, 1935.

[2] In these observation trips I was accompanied by Dr. Ira J. Condit, Visiting Professor of Horticulture at Lingnan, and Prof. Lei Tak Chuen, Assistant Professor of Vegetable Gardening in the College of Agriculture, Lingnan University, Canton. Professor Lei acted as guide and interpreter for us. The snapshots in figures 2-6 were taken by him. The other photographs used were taken by Doctor Condit. To both of them I owe a debt of gratitude.

mushroom culture on a commercial scale in Europe and America (Duggar, 1904; Atkinson, 1911).[3] For purposes of comparison, these two types, and also the types known in the Philippines, are here described briefly.

The English type consists of mushroom beds that are built flat. They are arranged as shelves, placed one above the other on each side of the cellar. The French type consists of ridge beds, which are built on the floor of the cave, each bed about 2 feet wide and not more than 18 to 20 inches high when conpressed and cased. The length varies, depending upon the size of the cave. They are placed side by side, leaving a little space between any two of them as a path on which to walk while watering and harvesting. In both types of bed, well cured manure, preferably horse dung, is used. The manure is piled on and pressed into the bed, and afterward watered. When sufficiently moist and the temperature is not more than 27.7°C., the bed is ready for spawning. Usually brick spawns are used.

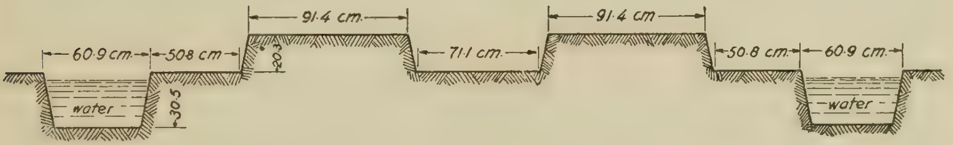

Fig. 1.—Profile of the soil foundation of two mushroom beds, canals and walks. The original dimensions were in feet and inches; hence, the fractions of a centimeter. The dimensions may vary in different mushroom beds. (Drawing by Mr. J. P. Mamisao of the Department of Agricultural Engineering.)

In the preparation of mushroom beds in the Philippines, Vicencio[4] reported that although none are employed on a large scale, four methods are known in Pampanga: (*a*) the rice-wash method, (*b*) the common salt method, (*c*) the sugar cane-bagasse method, and (*d*) the banana-refuse method. According to him, the first two methods consist of piling chopped rice straw in a convenient place. The bed is well packed and about 10 centimeters in thickness. In the rice-wash method, the water used in washing rice before cooking is used for watering. In the second method, the mushroom is watered with a weak brine, made with one table-spoonful of salt to one pail (eight liters) of water. The bagasse method uses sugar cane bagasse in making the mushroom bed. The bed is pressed down and watered with sugar cane juice scum, at least daily, for one month. In the banana-refuse method, a pile of chopped banana trunks, stumps and leaves about 45 centimeters in thickness or sometimes more forms the bed.

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[3] DUGGAR, B. M. 1904. The cultivation of mushrooms. U. S. Dept. Agric. Farmers' Bull. 204: 1–24.

ATKINSON, GEORGE F. 1911. Mushrooms. 3rd. ed. vii + 323 p., 250 illus. New York: Henry Holt and Co.

[4] VICENCIO, ARSENIO S. 1916. A study of mushroom culture in the Philippines. The Philippine Agriculturist and Forester 5: 119–128.

In constructing mushroom beds in the Canton region, however, rice straw and spawns from old mushroom beds are used. No manure is added, although the Chinese farmers are known to use much manure and even night soil rather freely in their fields and gardens. To increase heat by fermentation, peanut cakes are frequently inserted into the sides of the bed about forty days after spawning. In constructing mushroom beds experienced laborers are employed. In one of the fields we visited four men were engaged in building six beds, each man earned about 80 cents Canton currency

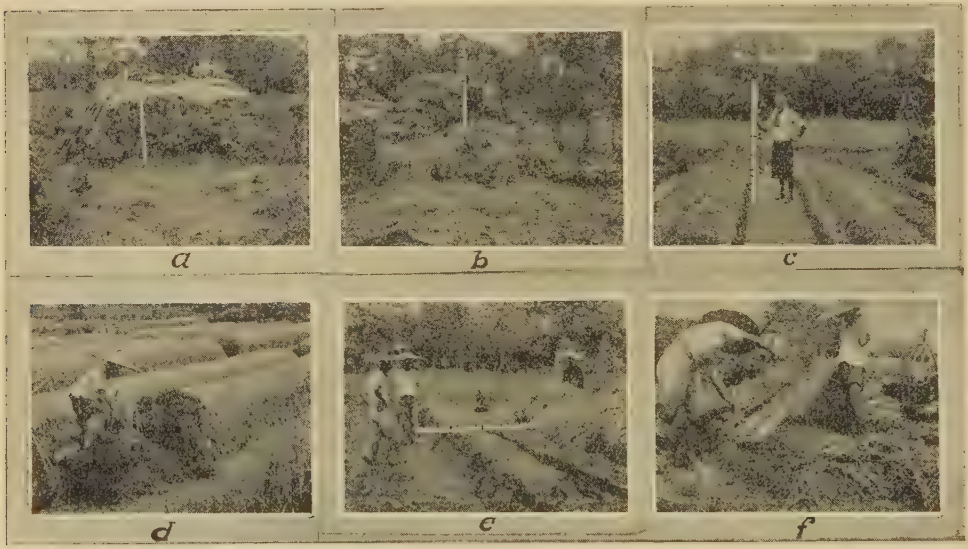

Fig. 2.—(*a*) Stack of rice straw, to be used in building mushroom beds. (*b*) Taking straw from the stack with which to build mushroom bed. (*c*) Two soil foundations ready for making mushroom beds, see figure 1 for dimensions. (*d*) This mushroom bed was built on May 3, 1935 and gathering of mushrooms began on May 23, 1935. At the beginning of the third "flush" of mushrooms, which appeared on June 9, 1935, this bed was partly broken down for spawn. (*e*) Height of bed is about 20.5 centimeters. The white stick laid across the bed is a 6-foot ruler, now marked in decimeters. In front of the ruler is a row of spawn distributed evenly along the edges of the bed. Beyond the ruler is the first layer of hanks of rice straw laid crosswise, entirely covering the spawns. (*f*) The man on the left is standing on the south side of the bed which is laid out east to west—laying down the second layer of rice straw crosswise.

a day, working from sunrise to sunset. Very few tools are used. The tools we saw were two long-bladed spades, a dipper with a long handle, and a portable Chinese footpump, a wooden contraption with which to draw water from a canal near the bed to another canal or to regulate the water content of the canal. This device works on the principle of a series of two endless chains to which are attached shallow buckets distributed at equal distances apart.

It requires 15 piculs of rice straw to build a mushroom bed 7 meters long and about 80 centimeters wide. The straw is of two kinds, coarse and fine; the coarser from lowland rice is preferred to the finer. The coarse straw is placed at the bottom of the bed, and the finer on top. The straw costs 60 cents (Canton money) a picul.

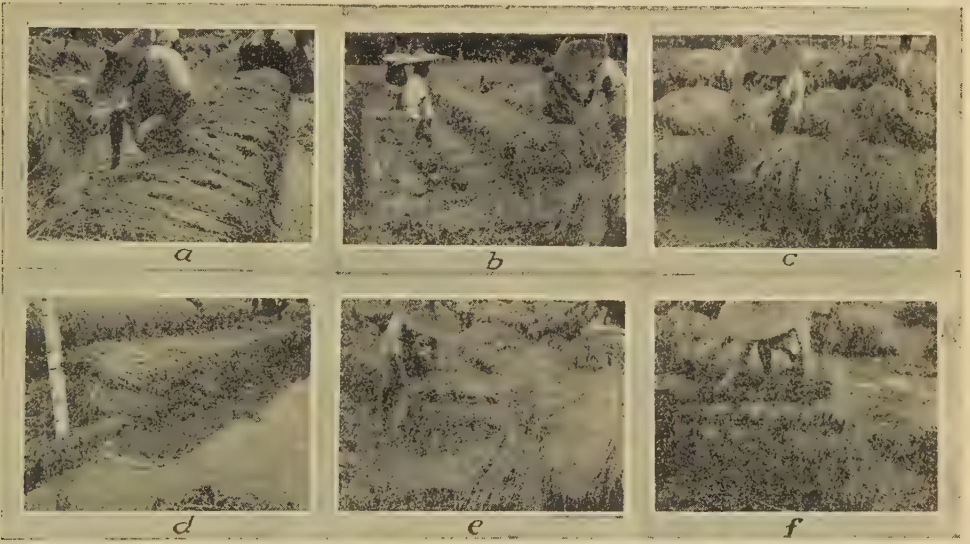

Fig. 3.—(*a*) The man is working from the north side of the bed bending or folding inward the ends of the second layer of straw so as to fit the breadth of the bed. (*b*) The man on the right side is piling the second layer of straw from the north side of the bed. The tip ends of the straw that are hanging on the south side of the bed are folded inward. The two workmen on the left are trampling the straw in the water in the furrow so as to make it soft and pliable. All straw is trampled for about ten minutes before using. (*c*) Piling the second layer of straw from the north side of another bed. Note the ends of the culms hanging down. These ends are bent inward as shown in figure 4c. (*d*) Bending inward the tip ends of straw from the south side of the bed shown in figure 4c. In front of the ruler is earth banked up to confine water for soaking straw. After completing the construction of the bed the water is drained off. (*e*) Bending the ends of the second layer of straw from the south side of bed shown in figure 3c. Note the position of the man and how he holds the straw. (*f*) After the second layer of straw is finished, spawn is put on top along the edges of the straw bed.

One old mushroom bed of standard size to be used as spawn costs $44 (Canton money). The spawn may, however, be purchased in smaller quantities, $5 a picul (Canton money).

Mushrooms are usually grown so that harvests coincide with two national festivals in China,—the Moon festival and the Dragon festival. The former usually falls on September 12, and the latter on June 5, the dates may, however, vary a little from year to year. If the mushrooms are to be raised for the Dragon festival, spawning is done on or about April 18; if for the Moon festival, on or about July 26. The six beds that we saw on a farmstead had been planted some time in February (fig. 8). They were to be used only for the production of spawns. On account of the cold winter in Canton, the last planting of spawn is made usually about August 15 and the last crop of mushrooms from this planting is gathered when the north, or cold wind comes, some time in the early part of October. On the farm we visited, the mushrooms are usually gathered twice a day, at four o'clock in the morning with a lantern, for light, and at ten o'clock in the forenoon. The first gathering is very early so the mushrooms can be delivered to Canton markets at eight o'clock on the same morning. The ten o'clock gathering is for the market at noon, or any time between twelve and one o'clock in the afternoon. We were told that one mushroom bed may yield as much as 50 "katties" (or 37.5 kilograms) of fresh mushrooms.

Two species of mushroom are generally grown in the Canton region. The larger species is rather dark in color; the smaller is white. The larger is said to be a species of *Volvaria*, similar to, if not identical with, the common species of edible mushroom in the Philippines, *Volvaria esculenta*[5]. The Canton species of *Volvaria* is said to be rather sensitive to the heat of the sun, and the fructifications usually appear in the bed rather scattered, more or less singly. On the other hand, the smaller type, probably a species of *Coprinus*, can stand the heat of the sun better and is said to be a more dependable crop; it is a heavier yielder and the mushrooms come out usually in groups or clusters.

My observation was that for successful mushroom culture in the Canton region, four things are needed; namely, a suitable site, clean dry straw, good spawn, and skilled laborers to build the mushroom bed. The beds are usually constructed in the fields or farms where irrigation water is available. The soil is fairly heavy, suitable for rice culture when well watered and for truck gardening when well drained. To obtain a fairly pure culture of mushrooms, clean straw is preferred to that which is dirty. Good viable spawn are essential, and experienced laborers contribute much to the success of the culture. The laborer should know not only where and when to build the mushroom beds, but he should also know the amount of water to use and when to use it. We were told by experienced mushroom growers in Canton that part of the success depends upon the method of watering, since too much water or too little water is conducive to low yield of mushrooms.

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[5] Benemerito in "Mushroom culture in Canton" in The Philippine Agriculturist 24: 624-634, considers this species as Bresadola's *Volvaria esculenta*.

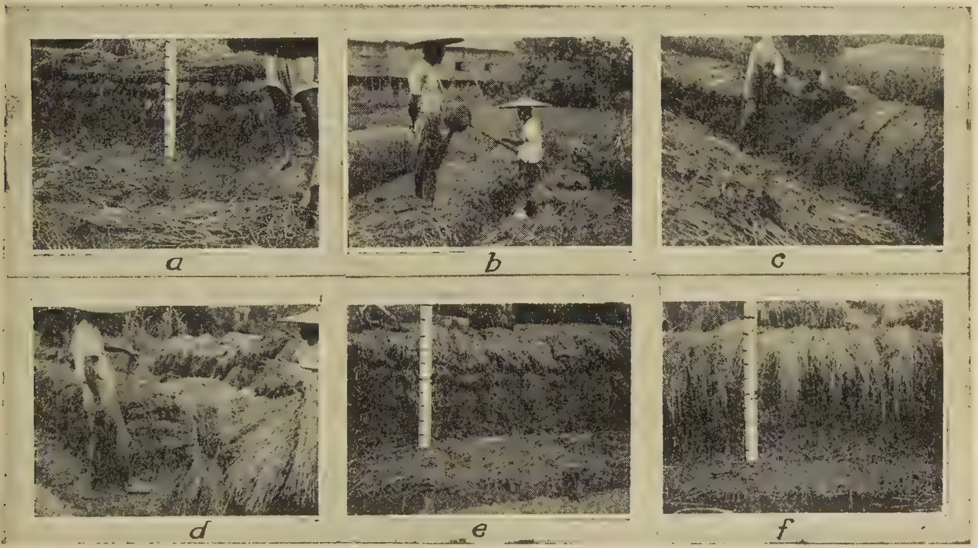

Fig. 4.—(*a*) After putting the second layer of spawn as shown in figure 3f, a rather thick layer of straw is placed lengthwise evenly on the bed. (*b*) Then, one man carefully tramples on the pile from one end of the bed to the other, while another man with a long handled dipper pours water over the part that is being trampled. When water begins to drip or ooze out from both sides of the straw bed, watering is stopped. (*c*) The man is bending the straw, starting from the north side of the bed. (*d*) Showing how the hank of straw is tied at the end of bed, to prevent it from falling off. (*e*) After the placing of the fourth layer of hanks of straw crosswise on the bed was finished, this photograph was taken from the south side of the bed. (*f*) The fifth layer of straw has been laid crosswise on the bed with the ends hanging on the south side of the bed..

The soil bed or foundation, (fig. 1 and 2c) is built first. Two foundations are usually built side by side, separated by a space of about 70 centimeters wide, although more soil foundations for mushroom beds may be built at the same time. Each foundation is about 91.5 centimeters wide, 20.3 centimeters high, and generally 7 meters long. The length may, however, vary to suit the topographical conditions of the land. About 50 centimeters from the outer side of each foundation, a shallow canal about 61 centimeters wide is constructed. This canal serves as reservoir for water. At times the water is allowed to overflow the flat surfaces or spaces near the soil foundations.

Along the sides or edges and the ends of a soil foundation, a row of spawn is evenly distributed, (fig. 2e). Thus, the first layer of spawn is planted; then the first layer of hanks[6] (fig. 7) of rice straw is laid crosswise on the bed, forming a continuous layer over the spawn. The butt ends of the culms of this layer of straw are placed along one side of the bed. The second layer of hanks of straw

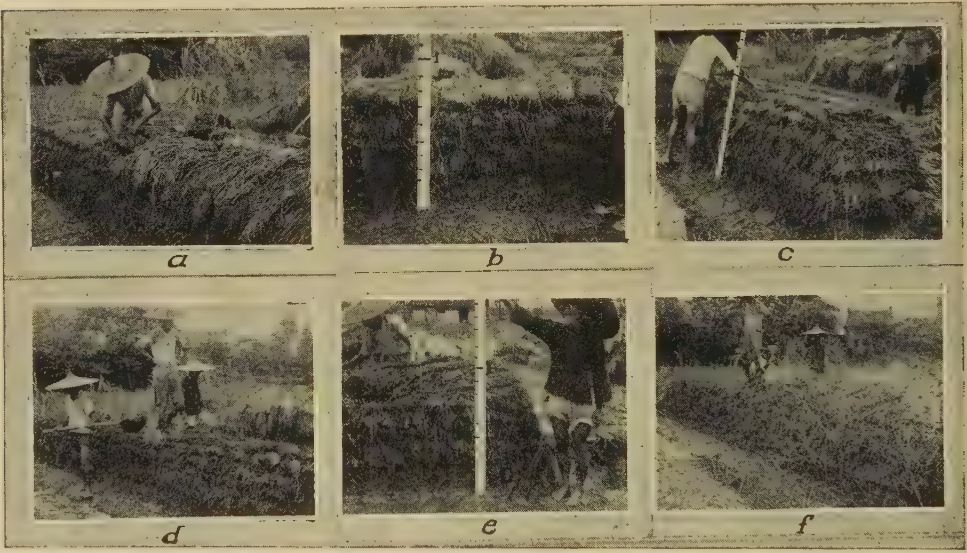

Fig. 5.—(*a*) Folding inward the tip ends of the straw in the fourth layer of straw to fit the width of the bed. Note how the man kneels and holds the straw as he works from the south side of the bed. (*b*) After the fifth layer of straw is placed crosswise on the bed. (*c*) Laying down the third layer of spawn on top of the fifth layer of straw placed crosswise on the bed. (*d*) Second watering with a long-handled dipper. The man in the middle is trampling the bed while the man on the left is pouring water. The third man on the right is trampling straw in the canal to make it pliable. (*e*) The sixth rather thick layer of straw is laid lengthwise on top of the third layer of spawn. (*f*) Although this is a double exposure, it shows the process of third watering.

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[6] A hank is one bunch of rice straw, about two handsful but not actually tied together into a bundle. The word is used merely to emphasize that the straw is laid on the bed in these small bunches one by one until the whole surface is covered.

is placed on top with the butt ends of the culms parallel to the other side of the bed. The tip ends of the two layers of straw are bent or folded inward to fit the width of the bed or foundation (fig. 1f; fig. 3a). To render it soft and pliable, before using, the straw is first trampled in the water in the canal for about ten minutes.

Then, the second layer of spawn is placed on top of the straw, along the sides and ends of the bed (fig. 3b). A third thick layer

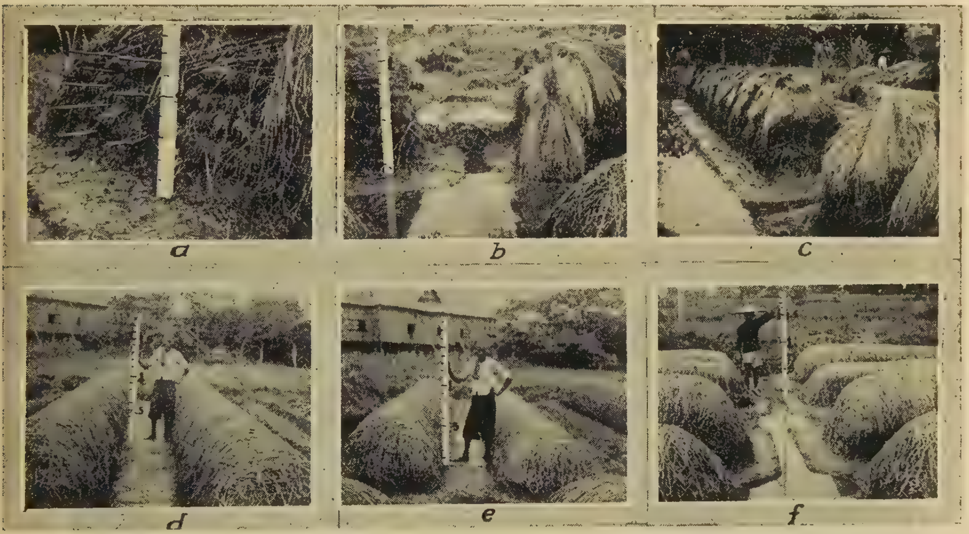

Fig. 6.—(*a*) Rear row of bamboo sticks from bottom to top: between bamboo sticks 1 and 2 is the first layer of straw laid crosswise; between bamboo sticks 2 and 3, the second layer of straw laid crosswise; between bamboo sticks 3 and 4, the third layer of straw laid crosswise, and between bamboo sticks 4 and 5, the fourth layer of straw also laid crosswise. Front row of bamboo: Bottom bamboo stick indicates the position of the first layer of spawn; the middle bamboo stick indicates the position of the second layer of spawn, and the uppermost bamboo stick indicates the position of the third layer of spawn. (*b*) On the left is shown one end of the bed without a temporary cover; while on the right is seen one end of another bed with a temporary cover put on. The bundle of straw that is put perpendicularly on the right is a sample of bundle of straw that is used for temporary cover. (*c*) Completed mushroom bed with temporary covers put on. The temperature inside of the bed is 30°C. This bed is left without watering for about one week. After which time, the temporary cover is taken off and trodden on the dry space between two beds until the straw is rendered pliable. (*d*) Then the straw is spread out to form small mats and placed, one by one, on top, sides and ends of the bed or until the bed is entirely covered. The temperature inside of the bed at this time is about 57°C. (*e*) These two beds were made on May 3, 1935. The front end of the left bed was torn down on May 27, 1935 for spawn, to be used in building a new bed part of which is shown on the right. On May 27, 1935, this torn down end was again built and connected at a point a little beyond the ruler. Note the difference in size of the front part and the rear part of this bed. (*f*) The four beds in the background were made on May 3, 1935; while the four beds in the foreground were built on May 27, 1935. Note the amount of shrinkage of the older beds.

of straw is spread uniformly, but this time lengthwise on top of the bed, fully covering the spawn (fig. 4a). Soon afterward, one man carefully starts trampling from end to end the unfinished bed, while another man with a long-handled dipper pours water over the part that is being trampled. When water begins to drip or ooze out from both sides of the straw bed, watering is stopped (fig. 4b). Care is taken in watering, since insufficient water may bring about "firing" or "heating" inside of the straw bed. Excessive watering is, likewise, detrimental, as it may unduly lower the temperature inside of the bed, and may wash off fungus spores and broken fungus mycelia.

The fourth layer of hanks of straw is laid crosswise on the bed. The butt ends of the straw of this layer are laid along one side of the bed, while the tip ends, if too long, are folded inward so as to fit with the width of the bed. This layer is soon followed by the fifth layer of hanks of straw, also laid crosswise, with the butt ends in line with the other side of the bed. The hanging tip ends of the straw, to fit with the width of the bed, are folded inward (fig. 4c; fig. 5a and b).

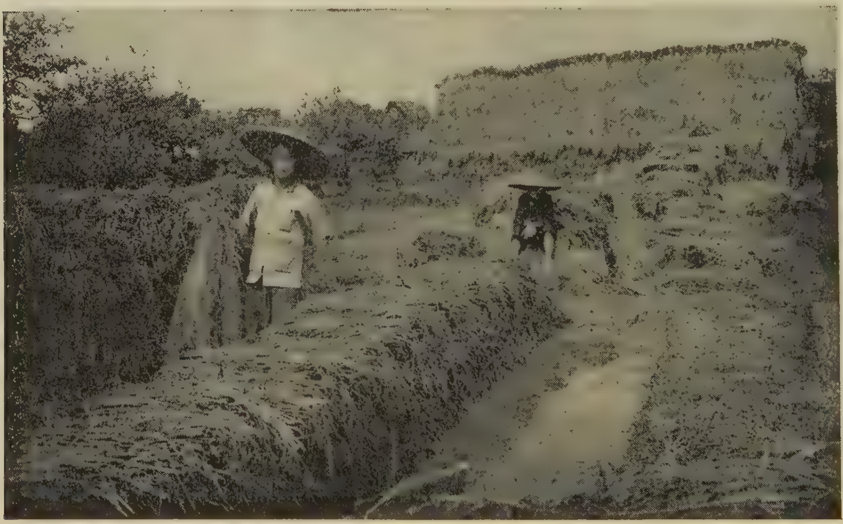

Fig. 7.—Mushrooms beds under construction on another farm. Note the water in the path between two bed and the piles of straw; also the hank of straw held by the man.

On top of the fifth layer of hanks of straw, one layer of spawn is planted in a manner similar to the previous planting (fig. 5c). On top of the spawn again is placed evenly lengthwise a rather thick layer of straw. Then soon follows watering and careful trampling of the straw at the same time (fig. 5d and f). This is the sixth layer of straw. Then hanks of straw are tied together into bundles at one end, and one by one the bundles are placed on top of the bed to serve as a temporary cover, (fig. 6b and c).

The bed is then left without watering for about one week, after which period, the temporary cover is taken off and trodden on the ground, that is, on the space between two beds, until the straw becomes soft and pliable. Once pliable, the straw is spread out like a mat and again placed, patch by patch, on top of the bed until it is covered all over on the top and sides, (fig. 6d; fig. 8). The temperature in the interior of the bed at this time is about 57°C. From time to time, as conditions demand, that is, whenever it is not raining regularly or when the humidity of the air is low, the mushroom bed is watered. In fact, success in mushroom culture in the Canton region seems to depend largely upon the frequent rain and high humidity of the air. My short stay in Canton coincided with the mushroom season in that place. There were days that were so humid that I could hardly write with crayon on the blackboard as the surface was covered with moisture.

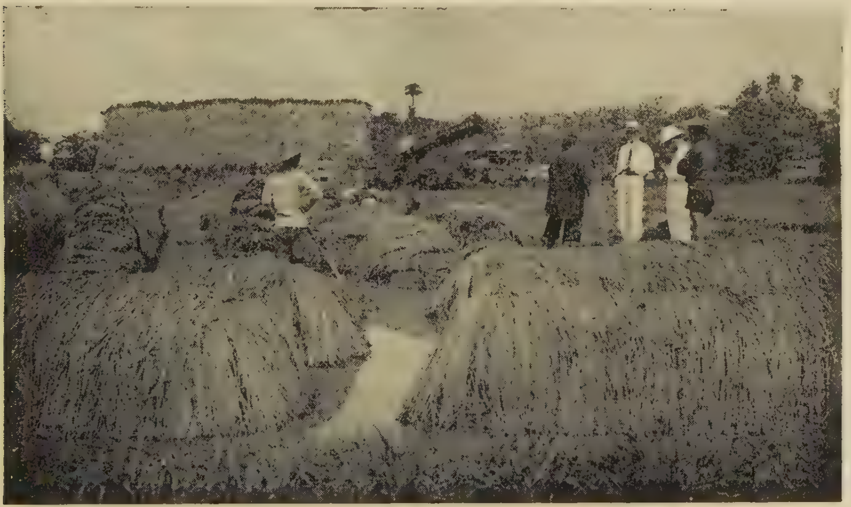

Fig. 8.—These mushroom beds with standing water around them were planted some time in February, 1935. Note the straw matting serving as permanent cover of the beds. This photo also shows how information was secured from the woman owner of the mushroom beds and from her trusted and experienced laborer.

On reaching maturity, the mushrooms appear among the straw along edges or sides and ends of the bed. To see or to gather them, the straw matting which covers the sides and ends of the bed is lifted up or pushed aside.

I have been told that not all the mushroom cultures in the Canton region are a success. As in other business or as with other crops, the beds sometimes fail to give good crops of mushrooms. Failures are attributed to various causes—principally lack of rain and low humidity of the air. They are also attributed to the use of poor spawns and, occasionally, to earthworms. To remedy the trouble alleged to earthworms, tobacco decoctions are liberally poured on the soil foundations and the neighboring area. This treatment is believed by some practical mushroom growers in Canton to be an effective means of killing the worms or of forcing them to come out of the soil.

ALCOHOL AND ALCOHOL-GASOLINE BLENDS AS FUELS FOR AUTOMOTIVE ENGINES: IV. PERFORMANCE CHARACTERISTICS OF ALCOHOL, ALCOHOL-GASOLINE MIXTURES, AND GASOLINE AS MOTOR FUELS UNDER DIFFERENT ROAD CONDITIONS[1]

A. L. TEODORO, A. B. CATAMBAY, E. K. ONGSANSOY AND J. P. MAMISAO
Of the Department of Agricultural Engineering

WITH ONE MAP AND ONE CHART

Motor fuels have become a large item of expense in the budget of car owners. Consequently there is a most remarkable activity in the search for a cheaper fuel that will give a satisfactory engine performance. For many years gasoline was thought to be the only satisfactory fuel for motor cars, but in recent years alcohol has been advocated especially in countries producing large quantities of sugar. Although, in the Philippines sugar is a leading product, alcohol was not given a practical trial until 1922 when it was used as fuel for tractors in sugar centrals. Ever since the introduction of stationary and automotive internal combustion engines, the Philippines has imported thousands of gallons of gasoline every year. The value of this imported fuel in 1933 amounted to ₱4,929,147. If, say, 20 per cent of this amount were spent on Philippine alcohol it would provide an outlet for a domestic product and keep a few hundred thousands of this nearly five million pesos at home.

OBJECTS OF THE WORK

The objects of the present study may be enumerated as follows:

1. To determine the fuel consumptions of a truck and an automobile when alcohol, gasoline-alcohol mixtures, and gasoline were used under different road conditions.

2. To determine the lubricating oil consumption after a definite number of hours of operation.

3. To observe and note the engine performance when using the different fuels.

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[1] Experiment Station contribution No. 1102. Received for publication September 24, 1935.

TIME AND PLACE OF THE DETERMINATIONS

The work was conducted from May, 1934 to January, 1935. The routes taken were as follows:

Route No. 1: College of Agriculture-Biñang-Manila-Quingua-Angat-Quingua-Gapan-Cabanatuan-San Jose-Balete Pass-San Jose Lupao-Biñang-College of Agriculture—646.0 kilometers (401.5 miles).

Route No. 2: College of Agriculture-Biñang-Manila-Quingua-Sibul Springs-Quingua-Manila-Biñang-College of Agriculture—309.4 kilometers (192.3 miles).

Route No. 3: College of Agriculture-Calamba-Canlubang-Canlubang Plantation-Canlubang-Calamba-College of Agriculture—80.1 kilometers (49.8 miles).

Route No. 4: College of Agriculture-Biñang-Manila-Tanay-Pagsanjan-Botocan Falls-Pagsanjan-Pila-Calauan-College of Agriculture—253.3 kilometers (157.4 miles).

Route No. 5: College of Agriculture-Calamba-Lipa-Rosario-Batangas-Taal-Nasugbu-Mendez Nuñez-Indang-Zapote-Biñang-College of Agriculture—300.9 kilometers (187.0 miles).

Route No. 6: College of Agriculture-Manila-Angeles-College of Agriculture—317.8 kilometers (197.5 miles).

Route No. 7: College of Agriculture-Manila—78.8 kilometers (49.0 miles).

Route No. 8: College of Agriculture-Calauan-Pagsanjan-Luisiana-Pagsanjan-Calauan-College of Agriculture—114.9 kilometers (71.4 miles).

Route No. 9: College of Agriculture-Calauan-Pagsanjan-Luisiana-Lucban-Tayabas-Lucena-Sariaya-Tiaong-San Pablo-Calauan - College of Agriculture—174.9 kilometers (108.7 miles).

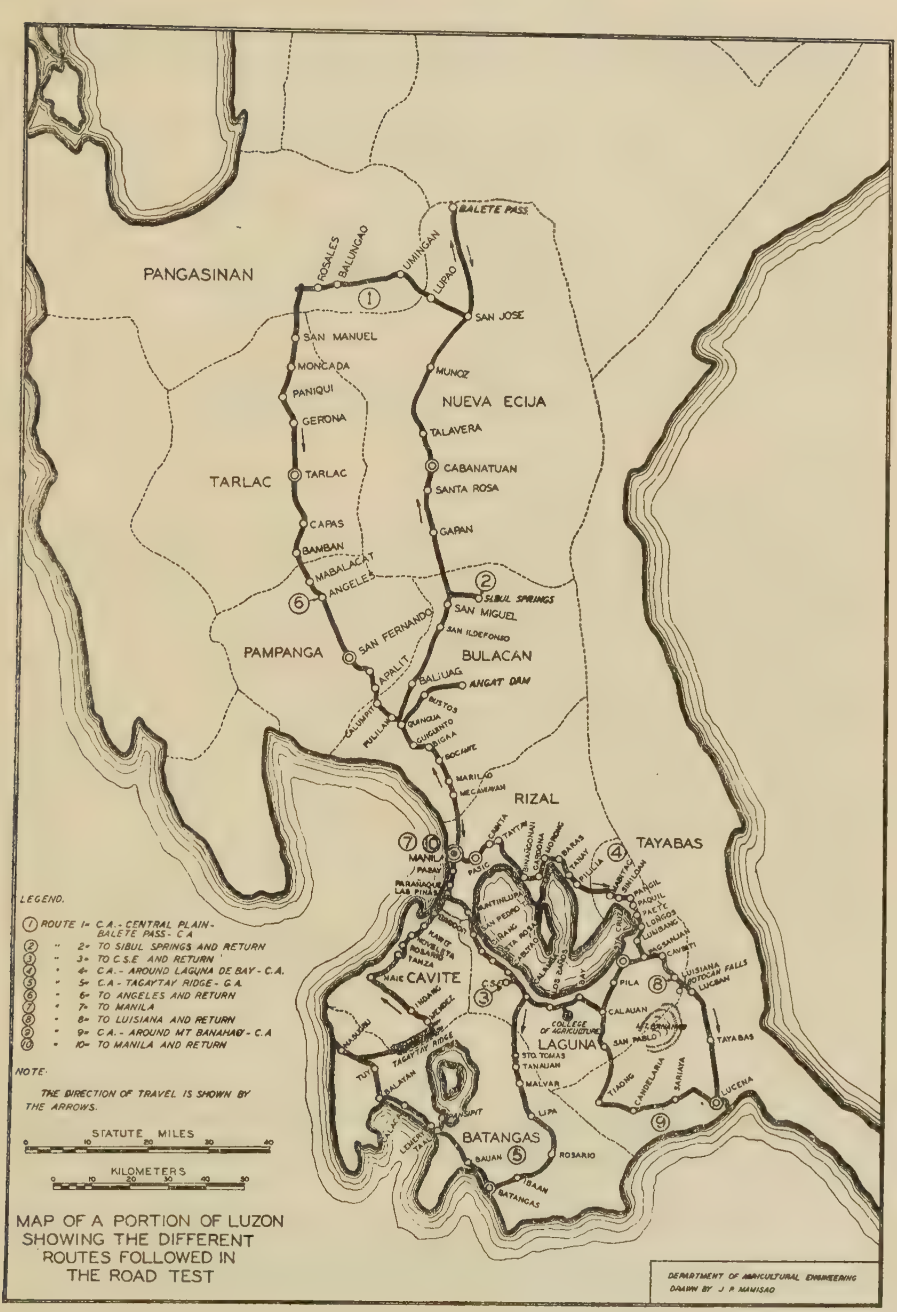
Route No. 10: College of Agriculture-Manila-College of Agriculture—157.7 kilometers (98.0 miles).

EQUIPMENT

Engines. Two Ford V-8 engines were used. One was mounted on a truck and the other on a five-passenger Sedan. The vehicles were lent by the Manila Trading and Supply Company. The engines have the following specifications:

Ford V-8 1½ ton truck model 1933

Bore, 3-1/16 in.
Stroke, 3-3/4 in.
Cylinders, 8
Type, V-90 degree crankshaft


PANGASINAN
ROSALES
BALUNGAO
UMINGAN
LUPAO
BALETE PASS
SAN JOSE
①
SAN MANUEL
MONCADA
PANIQUI
GERONA
TARLAC
TARLAC
CAPAS
BAMBAN
MABALACAT
ANGELES
⑥
MUNOZ
NUEVA ECIJA
TALAVERA
CABANATUAN
SANTA ROSA
GAPAN
②
SIBUL SPRINGS
SAN MIGUEL
SAN ILDEFONSO
PAMPANGA
SAN FERNANDO
APALIT
BULACAN
BALIUAG
ANGAT DAM
BUSTOS
CALUMPIT
PULILAN
QUINGUA
GUIGUINTO
BIGAA
BOCAUE
MARILAO
MECAUAYAN
RIZAL
⑦ ⑩
MANILA
PASAY
PARAÑAQUE
LAS PIÑAS
PASIC
CAINTA
TAYTAY
BINANGONAN
CARDONA
MORONG
BARAS
TANAY
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④
TAYABAS
MABITAC
SINILOAN
PANGIL
PAQUIL
PAETE
LOÑGOS
LUMBANG
PAGSANJAN
CAVINTI
MUNTINLUPA
SAN PEDRO
BIÑANG
STA ROSA
CABUYAO
CALAMBA
LOS BAÑOS
BAY
STA CRUZ
KAWIT
NOVELETA
ROSARIO
TANZA
NAIC
CAVITE
INDANG
MENDEZ
C.S.
③
PILA
⑧
LUISIANA
BOTOCAN FALLS
LUCBAN
CALAUAN
COLLEGE OF AGRICULTURE
MT. BANAHAO
LAGUNA
SAN PABLO
TAYABAS
STO. TOMAS
TANAUAN
MALVAR
TIAONG
CANDELARIA
SARIAYA
LUCENA
⑨
MAGALLANES
TAGAYTAY RIDGE
TUY
BALAYAN
CALACA
LEMERY
TAAL
BANSIPIT
BATANGAS
LIPA
BAUAN
⑤
ROSARIO
IBAAN
BATANGAS
LEGEND.
① ROUTE 1- C.A.- CENTRAL PLAIN- BALETE PASS- C.A
② " 2- TO SIBUL SPRINGS AND RETURN
③ " 3- TO C.S.E AND RETURN
④ " 4- C.A.- AROUND LAGUNA DE BAY - C.A.
⑤ " 5- C.A - TAGAYTAY RIDGE - C.A
⑥ " 6- TO ANGELES AND RETURN
⑦ " 7- TO MANILA
⑧ " 8- TO LUISIANA AND RETURN
⑨ " 9- C.A.- AROUND MT BANAHAO - C.A
⑩ " 10- TO MANILA AND RETURN
NOTE.
THE DIRECTION OF TRAVEL IS SHOWN BY THE ARROWS.
STATUTE MILES
0 10 20 30 40
KILOMETERS
0 10 20 30 40 50
MAP OF A PORTION OF LUZON SHOWING THE DIFFERENT ROUTES FOLLOWED IN THE ROAD TEST
DEPARTMENT OF AGRICULTURAL ENGINEERING
DRAWN BY J. P. MAMISAO

Fig. 1.—Map of a portion of Luzon showing the different routes followed in the road tests.

Engine suspension, 3 point
Weight with transmission and clutch, 615 lb.
Firing order, 1-5-4-8-6-3-7-2
Flywheel material, cast iron
Flywheel gear ratio to starter drive, 11.3 to 1
Lubrication—crankcase capacity, 5 qt.
Valve arrangement, L
Offset of cylinders, 3/16 in.
Horsepower rating, S.A.E. 30
Horsepower brake, 65 brake h.p. at 3400 r.p.m.
Displacement, 221 cu. in.
Compression ratio, 5.5 to 1
Compression pressure, 105-114 lb.

Fordor V-8, 5-passenger Sedan model 1934

Model, 40.
Cylinder arrangement, 90° crankshaft.
Firing order, 1-5-4-8-6-3-7-2.
Cylinder head, aluminum.
Piston displacement, 221 cu. in.
Taxable horsepower, 30.
Maximum brake horsepower, 90 at 3800 r.p.m.
Maximum torque, 147 ft. lb. at 1250 r.p.m.
Compression ratio, 6.3 to 1.
Standard compression pressure-
    138 lb. at 1600 r.p.m.
    At cranking speed, 105 lb.
Number of cylinders, eight.
Valve arrangement, "L" head.
Bore, 3-1/16″; Stroke, 3-3/4″.
Engine mounted on—Rubber front and rear.
Number of points of suspension, three.

Zenith mileage tester. A Zenith mileage tester was used in measuring the fuel consumption. The capacity of the bulb was 1/10 U. S. gallon.

Fuels

Gasoline was provided free of charge by the Asiatic Petroleum Company. The Calamba Sugar Estate furnished all the alcohol fuels used.

Two kinds of alcohol were used, namely: (1) Denatured dehydrated alcohol having a purity of 193° proof, and (2) Alkohl motor fuel No. 8.[2]

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[2] 100 parts by volume of 190° proof ethyl alcohol + 3 parts by volume of gasoline.

Blended fuels were prepared as follows:

1. Mixture A—95 per cent by vol. of gasoline + 5 per cent by vol. of denatured dehydrated alcohol.
2. Mixture B—90 per cent by vol. of gasoline + 10 per cent by vol. of denatured dehydrated alcohol.
3. Mixture C—85 per cent by vol. of gasoline + 15 per cent by vol. of denatured dehydrated alcohol.
4. Mixture D—80 per cent by vol. of gasoline + 20 per cent by vol. of denatured dehydrated alcohol.

OIL

The crankcase lubricating oil used was "Triple Shell" S.A.E. No. 40.

PROCEDURE OF TESTS

Two series of tests, A and B, were carried out using the Ford truck for series A and the Fordor Sedan for series B. In series A, gasoline and Alkohl motor fuel No. 8 were used; in series B, in addition to gasoline and to Alkohl motor fuel No. 8, mixtures A, B, C, and D were tested.

The truck was run for about 500 kilometers to break it in. Tests on alcohol were made after the carburetor was adjusted to perform satisfactorily and economically on this fuel. A new gasoline carburetor was used for all tests on gasoline. The diaphragm of the fuel pump was changed in accordance with the requirements for alcohol and for gasoline.

The tare and gross weights of the vehicles were determined before any test was made. The weights were made nearly the same for all tests under each series.

The mileage was determined by noting the speedometer distance traveled per every 1/10 of a gallon of the fuel used. The speed of the vehicles was made as constant as possible. The variation ranged from 40 to 55 kilometers an hour with the use of the truck and from 45 to 55 kilometers an hour with the use of the Sedan. The average speed with the use of truck was about 45 kilometers an hour and with the Sedan about 50 kilometers an hour.

The amount of crankcase oil used was determined in series A but not in series B. The condition of the road as to surfacing and grading was noted carefully. Engine performance with respect to acceleration, detonation, ease of starting, and power were observed.

RESULTS AND DISCUSSION

The results of tests in series A are shown in tables 1 and 2 and in series B in table 1. The weighted means of all data taken under a series of tests was calculated for each kind of road condition and for all roads and routes.

Series A

The following observations are indicated with regard to the use of gasoline and of Alkohl motor fuel No. 8 in a Ford V-8 truck 1933:

1. That greater mileage could be obtained with gasoline than with Alkohl motor fuel No. 8. With gasoline as 100 per cent, the efficiency in Alkohl motor fuel No. 8 varied from 68.0 to 83.6 per cent. The mileage ranged from 6.08 to 7.75 in Alkohl motor fuel and from 7.84 to 10.48 in gasoline.

2. That with the use of alcohol, higher efficiency was obtained on smooth gravel roads than on asphalt roads. The difference varied from about 1.5 per cent to 5.0 per cent. The average for asphalt road was 73.5 per cent and for smooth gravel road 76.4 per cent.

3. That on the concrete road, the efficiency for alcohol was about 71.9 per cent and on the loose gravel road, 83.6 per cent. (Note the high efficiency obtained with alcohol on loose gravel.)

4. That the crankcase oil consumption was slightly greater with the use of alcohol than with gasoline. For every 100 ton-km., the amount of oil used averaged 19.8 cc. for alcohol and 17.9 cc. for gasoline.

5. That, in general, in hill climbing and on rough roads engine performance with alcohol was a little better than with gasoline. Engine starting from cold was quicker with gasoline than with alcohol. Acceleration was faster with gasoline than with alcohol at low speeds and in turning corners.

Series B

A study of the results in series B, shows the following:

1. That with the use of power jet on route No. 6, under all conditions of the road, higher efficiency was obtained with alcohol-gasoline mixtures than with gasoline. With gasoline, as 100 per cent, the efficiency of the mixtures varied from 104.9 to 106.0 per cent on all roads; from 103.1 to 105.2 per cent on asphalt road; and from 113.4 to 116.8 per cent on concrete road. The efficiency of Alkohl motor fuel No. 8 varied from 70.2 to 77.9 per cent.

The results indicated that the efficiency of the mixtures increased as the percentage of alcohol in the mixture was increased up to 15 per cent. In mixture D, where the mileage was still greater than with gasoline, engine acceleration was a little slower and operation at lower speed was sometimes shaky.

Short trial tests with the use of economical jets showed nearly the same trend of results, but gave slightly greater mileage than using power jets for each fuel. The increase varied from about 0.6 per cent to as high as 8.0 per cent.

2. That on route No. 7, practically no difference in mileage was obtained between gasoline and the mixture A. With gasoline as 100 per cent the efficiency in mixture B was 98.1 per cent, in mixture C, 107.4 per cent, and in mixture D, 104.0 per cent.

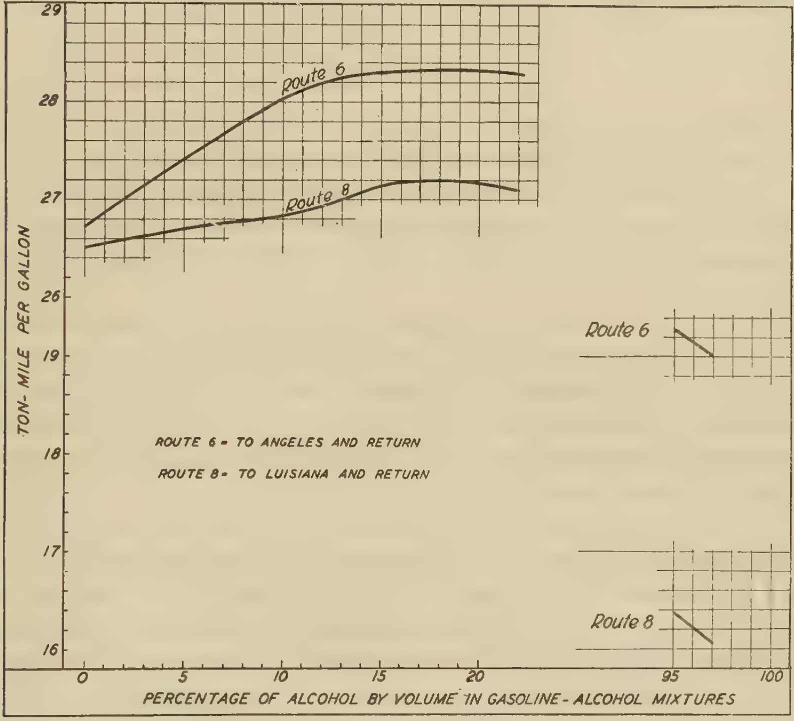

Chart 1.—Chart showing the mileage obtained for the different fuels in series B.

3. That on route No. 8, where there were hill climbing, zigzags, and rough roads, it was shown, in general, that alcohol-gasoline mixtures were more efficient than gasoline, and that the higher the percentage of alcohol in the mixture, the higher was the efficiency. The efficiency on all roads was from 100.8 to 102.6 per cent; on level road from 100.7 to 101.3 per cent; on up-hill, from 102.3 to 107.5 per

cent; and on down-hill, from 102.5 to 107.3 per cent. Alkohl motor fuel had an efficiency of 57.5 to 61.6 per cent. Operation of the engine using mixture D was similar to the behavior obtained on route No. 6.

4. That on routes Nos. 9 and 10, the efficiency in mixture B was from 104.7 to 111.7 per cent and in Alkohl motor fuel No. 8 from 63.5 to 70.1 per cent.

5. That there was evidence of detonation when gasoline was used on hilly and on rough roads. In none of the tests was such behavior shown by any of the alcohol-gasoline mixtures or by the Alkohl motor fuel No. 8.

CONCLUSIONS

Under the conditions in which the road tests were carried out using Ford V-8 engines, the following conclusions may be drawn:

1. With gasoline as 100 per cent, the minimum efficiency obtained with the use of Alkohl motor fuel No. 8 was 57.5 per cent and the maximum, 83.6 per cent. A fair weighted average was about 73.0 per cent.

2. An alcohol-gasoline mixture containing 5 per cent by volume of denatured dehydrated 193° proof ethyl alcohol gave practically the same mileage as gasoline. Since detonation was minimized with the addition of alcohol, the efficiency of the mixture on hilly roads, where gasoline showed evidence of knocking, was higher by about 2 per cent than gasoline.

3. The use of mixtures containing 10 to 20 per cent by volume of denatured dehydrated 193° proof ethyl alcohol, exceeded the efficiency of gasoline by an amount varying from 0.7 to 16.8 per cent. Some tests showed that the efficiency of the mixture increased as the percentage of alcohol in the mixture was increased to 15 per cent.

4. The performance of the engine using a mixture containing 20 per cent by volume of denatured dehydrated 193° proof alcohol was characterized by slower acceleration on low speeds and by rather poor idling.

5. It was indicated that the oil consumption expressed in cc./100 ton-km. was about 10 per cent higher in the use of Alkohl motor fuel No. 8 than in gasoline.

6. Starting from cold, using Alkohl motor fuel No. 8, was not so fast as with the use of gasoline. Without any change in the engine adjustment, road performance with the use of mixtures containing as high as 15 per cent denatured dehydrated 193° proof ethyl alcohol was practically the same as gasoline.

TABLE 1

Showing summary of results in all tests in series A. (Ford truck V–8 1933)

ROUTE	FUEL	ROAD CONDITIONS									WEIGHT OF CAR	EFFICIENCY (BASED ON TON-MI./GAL.)		
		All roads			Asphalt			Smooth gravel				All roads	Asphalt	Smooth gravel
		km./l.	*mi./gal.*	*ton-mi./gal.*	*km./l.*	*mi./gal.*	*ton-mi./gal.*	*km./l.*	*mi./gal.*	*ton-mi./gal.*	*m. t.*	*per cent*	*per cent*	*per cent*
No. 1	Alkohl	3.03	7.12	30.76	3.14	7.38	31.90	2.94	6.92	29.91	4.325	78.1	76.2	79.8
(401.5 mi.)	Gasoline	3.87	9.10	39.40	4.11	9.67	41.85	3.68	8.66	37.49	4.328	100.0	100.0	100.0
No. 2	Alkohl	3.19	7.50	33.94	3.26	7.66	34.67	3.01	7.08	32.05	4.525	74.4	73.4	78.4
(192.3 mi.)	Gasoline	4.30	10.11	45.60	4.46	10.48	47.25	3.85	9.06	40.88	4.510	100.0	100.0	100.0
No. 3	Alkohl	3.08	7.24	31.67	3.15	7.40	32.33	3.05	7.16	31.30	4.370	73.8	73.3	74.8
(49.8 mi.)	Gasoline	4.28	10.06	42.90	4.40	10.34	44.12	4.17	9.80	41.82	4.270	100.0	100.0	100.0
No. 4	Alkohl	2.84	6.68	28.72	3.15	7.42	31.90	2.59	6.08	26.14	4.300	73.6	72.9	77.0
(157.4 mi.)	Gasoline	3.83	9.02	39.02	4.30	10.11	43.77	3.33	7.84	33.95	4.330	100.0	100.0	100.0
No. 5	Alkohl	3.05	7.17	30.37	3.15	7.41	31.39	3.30	7.75	32.85	4.237	69.9	68.8	72.0
(187.0 mi.)	Gasoline	4.18	9.83	43.50	4.38	10.31	45.61	4.39	10.31	45.63	4.424	100.0	100.0	100.0
All	Alkohl	3.06	7.12	30.89	3.18	7.48	32.42	2.94	6.92	30.03	4.340	74.7	73.5	76.4
routes	Gasoline	4.02	9.45	41.36	4.29	10.08	44.12	3.82	8.98	39.29	4.376	100.0	100.0	100.0

ROUTE	FUEL	ROAD CONDITIONS						EFFICIENCY (BASED ON TON-MI./*gal.*)	
		Concrete			Loose gravel			Concrete	Loose gravel
		km./l.	*mi./gal.*	*ton-mi./gal.*	*km./l.*	*mi./gal.*	*ton-mi./gal.*	*per cent*	*per cent*
No. 1	Alkohl	3.45	8.12	35.12	2.88	6.77	29.29	71.9	83.6
(401.5 mi.)	Gasoline	4.80	11.29	48.86	3.44	8.09	35.02	100.0	100.0

TABLE 2

Oil consumption[a] *(Ford truck V-8 1933 model)*

	ROUTE	DISTANCE IN KM.		TOTAL IN CC.		CC./100 TON-KM.		REMARKS
		Alkohl	Gasoline	Alkohl	Gasoline	Alkohl	Gasoline	
Consumption in Metric units	Routes 1 and 2	695.8	694.2	570	510	18.9	17.0	With a climb
	Routes 2 and 3	389.6	391.9	240	230	13.6	13.0	Level
	Route 5	301.0	312.8	300	210	23.5	15.7	With a climb
	All routes	1453.0	1472.0	1250	1150	19.8	17.9	
		DISTANCE IN MI.		TOTAL IN U. S. PINTS		U. S. PINTS PER 1000 TON-MI.		
Consumption in English units	Routes 1 and 2	432.0	431.5	1.20	1.08	0.64	0.58	With a climb
	Routes 2 and 3	242.0	305.6	0.51	0.49	0.46	0.44	Level
	Route 5	187.0	194.3	0.63	0.44	0.80	0.53	With a climb
	All routes	903.0	915.0	2.64	2.43	0.67	0.61	
				Approx.		110.0	100	All routes

[a] Dilution of oil not considered.

TABLE 3

Showing summary of results in all tests in series B. (Ford Sedan V–8 1934)

MILEAGE	GASOLINE	MIXTURES				ALKOHL MOTOR FUEL NO. 8	ROUTE
		A 5 per cent	B 10 per cent	C 15 per cent	D 20 per cent		
All roads							
Km./l.	6.97	Not used	7.32	7.39	7.40	5.04	Route No. 6—College of Agriculture-Manila Angeles-Manila-College of Agriculture—197.5 miles
Mi./gal.	16.39		17.20	17.36	17.38	11.83	
Ton-mi./gal.	26.72		28.04	28.30	28.33	19.01	
Percentage	100.00		104.90	105.90	106.00	71.20	
Asphalt road							
Km./l.	7.07	Not used	7.29	7.44	7.42	5.05	Jet No. 50 for gasoline and for mixtures B, C, and D. Jet No. 59.5 for Alkohl motor fuel No. 8
Mi./gal.	16.63		17.15	17.49	17.44	11.85	
Ton-mi./gal.	27.12		27.96	28.52	28.43	19.03	
Percentage	100.00		103.10	105.20	104.80	70.20	
Concrete road							
Km./l.	6.34	Not used	7.41	7.19	7.32	5.02	Weight of car = 1.63 m.t. in gasoline and in mixtures B, C, and D tests. = 1.604 m.t. in Alkohl motor fuel No. 8 test. Average speed of car = 45-55 km./hour.
Mi./gal.	14.90		17.41	16.91	17.21	11.80	
Ton-mi./gal.	24.29		28.38	27.57	28.05	18.93	
Percentage	100.00		116.80	113.40	115.50	77.90	
All roads							
Km./l.	7.23	6.98	7.13	7.76	7.52	Not used	Route No. 7—College of Agriculture-Manila—49 miles. Jet No. 50 for gasoline and for mixtures A, B, C, and D. Weight of car = 1.63 m.t. in gasoline and in mixtures B, C, and D tests. = 1.71 m.t. in mixture A test. Average speed of car = 45-55 km./hour.
Mi./gal.	16.98	16.41	16.75	18.24	17.67		
Ton-mi./gal.	27.70	28.05	27.13	29.73	28.81		
Percentage	100.00	100.10	98.10	107.40	104.00		

TABLE 3 (Continued)

MILEAGE	GASOLINE	MIXTURES				ALKOHL MOTOR FUEL NO. 8	ROUTE
		A 5 per cent	B 10 per cent	C 15 per cent	D 20 per cent		
				All roads			
Km./l.	7.19	7.24	7.28	7.36	7.37	4.36	Route No. 8—College of Agriculture-Calauan-Pagsanjan-Luisiana-Pagsanjan-Calauan-College of Agriculture—71.4 miles.
Mi./gal.	16.90	17.02	17.10	17.31	17.33	10.25	
Ton-mi./gal.	26.51	26.70	26.82	27.16	27.18	16.07	
Percentage	100.00	100.80	101.20	102.40	102.60	60.60	
				Level road			
Km./l.	7.27	7.27	7.32	7.36	7.35	4.48	Jet No. 46 for gasoline and for mixtures A, B, C, and D. Jet No. 59.5 for Alkohl motor fuel No. 8. Weight of car = 1.568 m.t. in all tests.
Mi./gal.	17.08	17.08	17.19	17.30	17.27	10.53	
Ton-mi./gal.	26.80	26.80	26.97	27.14	27.09	16.52	
Percentage	100.00	100.00	100.70	101.30	101.10	61.60	
				Up hill			
Km./l.	5.96	6.09	6.19	6.32	6.42	3.58	Average speed of car on level = 40 km./hour. up hill = 30 km./hour. down hill = 35 km./hour.
Mi./gal.	14.02	14.33	14.56	14.87	15.09	8.42	
Ton-mi./gal.	21.99	22.47	22.83	23.32	23.67	13.18	
Percentage	100.00	102.30	103.80	106.10	107.50	60.10	
				Down hill			
Km./l.	8.56	8.77	8.92	9.18	9.18	4.92	
Mi./gal.	20.12	20.62	20.97	21.58	21.58	11.57	
Ton-mi./gal.	31.57	32.34	32.88	33.85	33.85	18.16	
Percentage	100.00	102.50	104.20	107.30	107.30	57.50	

TABLE 3 (Continued)

MILEAGE	GASOLINE	MIXTURES				ALKOHL MOTOR FUEL NO. 8	ROUTE
		A 5 per cent	B 10 per cent	C 15 per cent	D 20 per cent		
All roads							
Km./l.	7.10	Not used	7.45	Not used	Not used	4.56	Route No. 9—College of Agriculture-Calauan-Pagsanjan-Luisiana-Lucban-Tayabas-Lucena-Sariaya-Tiaong-San Pablo-Calauan-College of Agriculture—108.7 miles. Jet No. 46 for gasoline and for mixture B. Jet No. 59.5 for Alkohl motor fuel No. 8. Weight of car = 1.659 m.t. in gasoline test. = 1.654 m.t. in mixture B test. = 1.640 m.t. in Alkohl motor fuel No. 8 test. Average speed of car = 45-55 km./hour.
Mi./gal.	16.69		17.52			10.73	
Ton-mi./gal.	27.71		28.99			17.60	
Percentage	100.00		104.70			63.50	
All roads							
Km./l.	7.30	Not used	8.18	Not used	Not used	4.93	Route No. 10—College of Agriculture-Manila-College of Agriculture—98 miles. Jet No. 46 for gasoline and for mixture B. Jet No. 59.5 for Alkohl motor fuel No. 8. Weight of car = 1.604 m.t. in gasoline test. = 1.600 m.t. in mixture B test. = 1.663 m.t. in Alkohl motor fuel No. 8 test. Average speed of car = 45-55 km./hour.
Mi./gal.	17.15		19.21			11.58	
Ton-mi./gal.	27.52		30.75			19.27	
Percentage	100.00		111.70			70.10	

SOME PRELIMINARY STUDIES, UNDER FIELD CONDITIONS, ON THE PROPAGATION BY STEM CUTTINGS OF THREE SPECIES OF DERRIS[1]

MARCOS J. ALDAMA

WITH FOUR TEXT FIGURES AND TWO CHARTS

As used in this paper the genus *Derris* Lour. applies to the poisonous species, only. Roark in his article, "A digest of the literature of *Derris* (*Deguelia*) species used as insecticides, 1747-1931," published in 1932 by the United States Department of Agriculture, listed these poisonous species as follows:

a. Fish poison—*Benthamii, elliptica, forsteniana, guianensis, negrensis, philippinensis, pinnata, polyantha, scandens* and *uliginosa*.

b. Insecticides—*Chinensis, elliptica, heptaphylla, malaccensis, philippinensis, polyantha, thyrsiflora*, and *uliginosa* (*trifoliata*).

The use of *Derris* as a fish poison was reported by Marsden as early as 1811 in Sumatra; Oxley in 1848 gave an account of it as an insecticide effective in control of several insect species damaging nutmeg trees (Roark, 1932). In the Philippines, although probably long before in vogue, the roots of *Derris polyantha* Perk. was mentioned by Bacon (1906), and *Derris elliptica* (Roxb.) Benth. and *Derris philippinensis* Merr. by Brown (1921) as being used by Filipinos for stupefying fish.

At present, the increasing popularity of *Derris* is due to its use in the preparation of proprietary organic insecticides.

No data are available on the export of *Derris* from the Philippines. In a communication from Mr. Cornelio Balmaceda, Director of the Bureau of Commerce, the writer was informed that in customs statistics, the occasional shipments of the roots are classified under "medicinal and pharmaceutical preparations". From other countries, however, figures may be given to show the extent of the demand for *Derris*. Foote in 1929 reported that 2,000 pounds of roots were sent to the United States from Sumatra in 1928 (Roark, 1932). From the Federated Malay States, according to Georgi and Curtler

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(1929), the exports amounted to 80,263 pounds valued at $0.19 a pound (United States currency). Hendren in 1931 stated that tuba root exports in 1928 from Sarawak were 469 tons and in 1929, 704 tons, the latter valued at $81,403 (Roark, 1932). A more recent shipment from Malaya was 15 tons in November, 1934 (Anonymous, 1935).

Although for many years, in the Philippines, some species of *Derris* have been known for their toxic effect on fish and for their value as insecticides, very little, if any, specific information has been reported regarding the best method of propagation by asexual means. In view of this limited knowledge and the growing interest in *Derris* in the Philippines, the experiment herein reported on some preliminary studies under field conditions on the propagation of three species by stem cuttings were undertaken.

REVIEW OF LITERATURE

Roark (1932) made a digest of the voluminous literature on *Derris* species used as insecticides from 1747 to 1931. His citations deal mostly with the various uses of the plant, especially in its use as insecticide, methods of extraction and miscellaneous phases of work on this plant.

Literature on *Derris* from 1932 to the present from other countries, especially in the tropics, is abundant, but because it has no direct bearing on the present subject, no article is here reviewed.

So far as the writer knows very little work has been done on *Derris* in the Philippines, especially on its cultivation. Guerrero (1910) made preliminary chemical and pharmacological tests of *Derris philippinensis.* In 1915, in the College of Agriculture, Miraflores studied asexual propagation of some Philippine dicotyledonous plants by stem cuttings and marcottage. He found that *Derris philippinensis* could be reproduced by these means, using sandy soil as a medium. Castillo (1926) made the first attempt to use roots of *Derris elliptica, D.* (?) *polyantha,* and *D. philippinensis* as insecticide against aphids and mosquito larvae. Uichanco (1933) made a study of three species of Philippine *Derris;* namely, *D. philippinensis, D. elliptica* and an unidentified species. She cited numerous investigations from other countries. Her main work dealt with the chemical analysis of the roots and extraction of rotenone, and some insecticidal tests were made.

The cultivation, toxic constituents, uses, and chemical analysis and extraction of *Derris* was discussed by Adriano (1934). Later in the same year, crude rotenone content of *Derris* roots obtained from different provinces in Luzon, Cebu, and Mindanao were analyzed (Adriano *et al*, 1934).

OBJECTS AND TIME AND PLACE OF THE WORK

The objects of this experiment were: (*a*) To find out the size of *Derris* cuttings most suitable for commercial planting; and (*b*) to determine the percentage of shoot formation in cuttings in different months of the year.

This work was carried out on lots on Faculty Hill at the College of Agriculture from February, 1934 to January, 1935.

MATERIALS AND METHODS

Sources of materials

Stem cuttings of *Derris elliptica* and *D. philippinensis* were obtained, at approximately 50 to 200 meters elevation, from forests near the School of Forestry and the College of Agriculture. *D. polyantha* stems were gathered from time to time at Lalacay, a barrio in Los Baños, Laguna.

Description of materials

The *Derris* species used in this study were viny, differing greatly as to leaf and stem structure. Merrill (1923) in volume 2, pages 299-301 in his *Enumeration of Philippine flowering plants* gives the distribution and local names of the three species used in this experiment as follows:

1. *Derris elliptica* (Roxb.) Benth.
   Local names: Bauit (Tag.), tubali (Bag.), tubli (P.Bis., Tag., Bik.), tugli (Tag.), tugling pula (Tag.), tuva (Iv.), and upei (Bon.). Found in thickets along streams, secondary forests, etc., at low and medium altitudes; often abundant. Northern Luzon to Mindanao. Chittagong through Malaya to New Guinea and Bismarck Archipelago.
2. *Derris polyantha* Perk.
   Local names: Timalang (Tag.), tugali (Tag.), tuglon (Tag.), tuglun (Tag.). Found in thickets and secondary forests at low altitude. Luzon (Pampanga, Pangasinan, Laguna, Rizal and Batangas). Endemic.
3. *Derris philippinensis* Merr.
   Local names: Upi (Ig.). Found in thickets at low and medium altitudes ascending to 1,400 meters. Luzon (Cagayan, Ilocos Norte, Benguet, Rizal, Laguna, Bataan, Tayabas, Camarines). Endemic.

Area and description of the land

As one lot large enough for the experiment was not available, two fields were used. The first field is open, that is, with no tall trees on it. It is, however, planted to achuete (*Bixa orellana* Linn.) and African oil palm (*Elaeis guineensis Jacq.*). The achuete is about four years old, spaced at six by six meters, and the oil palm is about three years old, also planted six by six meters. The area of this field is about 580 square meters. Because of a shallow ravine the land slopes towards the north. The soil is of ordinary clay loam.

The second field is under forest trees, which afford a general uniform shade, but under which planting could be done conveniently. Only a small portion (about 50 square meters) is exposed. Its area is about half of a hectare, and the soil is of ordinary clay loam.

Preparation of the land

The land was prepared in a simple manner. As plowing was impractical, primarily on account of the contour of the land, and secondly, because of the achuete trees and African oil palms on the first field, and large trees on the second field, the cleaning was done with native hoes, sickles, bolos and like implements. The weeds that were cut down in cleaning were piled as mulch between the rows intended for planting.

When the land was thoroughly cleaned, thirty-six plots, 2 × 8 meters were prepared in the first field. The second field was not used until June, 1934, after the first field had been planted. In preparing the second field rows were used as the plot system was inconvenient because of the trees. The rows were spaced one meter apart. With a digging hoe, holes were dug 50 centimeters apart in the row and about 15 centimeters deep.

Gathering and preparation of the cuttings

As plantings were monthly, the cuttings were gathered and prepared each month. Stems of the plant material were gathered in the forest and cut in proper lengths just before planting. No plant selection was made, that is, any plant found in the course of searching in the forest was used as planting material. Only the portions of the stem which ranged from one centimeter to three centimeters in diameter were used.

A sharp bolo was used in cutting. The base (proximal end) of the cuttings was cut on a slant on any place on the stem without particular attention to the nodes. This procedure was followed primarily to facilitate the cutting and secondly for economy in material. With a meter stick as a measure, six sizes of cuttings were prepared for each species. The sizes were as follows:

(1) 15 cm. long, 1 cm. in diameter
(2) 15 cm. ” , 2 cm. ” ”
(3) 15 cm. ” , 3 cm. ” ”
(4) 30 cm. ” , 1 cm. ” ”
(5) 30 cm. ” , 2 cm. ” ”
(6) 30 cm. ” , 3 cm. ” ”

Cuttings 1 cm., 2 cm., and 3 cm. in diameter were found to be more easily secured than the other sizes, as 0.5 cm., 4 cm., and 5 cm., of the two designated lengths. The lengths were fixed at 15 and 30 centimeters for the purpose of comparison. The cuttings possessed two or three nodes and buds or even four in some cases.

FIELD 1

(Open Field)

Planting Plan of First Set

C 15-3	A 15-3	B 15-3	C 30-1	A 30-1	B 30-1	C 15-2	A 15-2	B 15-2	C 30-3	A 30-3	B 30-3
B 15-2	C 15-2	A 15-2	B 30-3	C 30-3	A 30-3	B 15-1	C 15-1	A 15-1	B 30-2	C 30-2	A 30-2
A 15-1	B 15-1	C 15-1	A 30-2	B 30-2	C 30-2	A 15-3	B 15-3	C 15-3	A 30-1	B 30-1	C 30-1

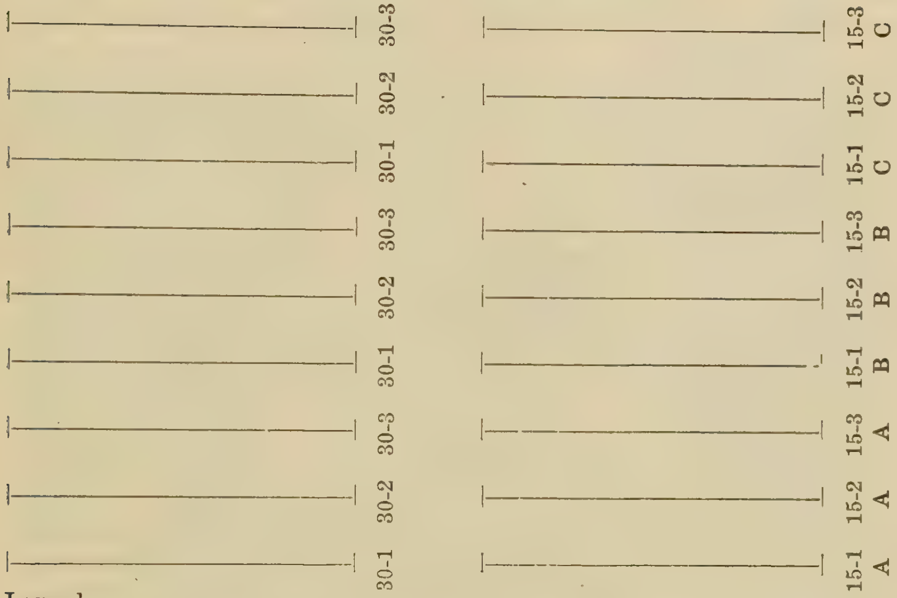
Legend:

A, plots for *D. elliptica;* B, plots for *D. polyantha;* C, plots for *D. philippinensis.* Plots 2 × 8 meters each, 50 cuttings in each plot. Size of cuttings, 15-1, 15-2, 15-3, 30-1, etc.

FIELD 2

(Under Trees)

Planting Plan of Second Set



Legend:

A, plots for *D. elliptica;* B, plots for *D. polyantha;* C, plots for *D. philippinensis.* Distance between rows, 1 meter. Size of cuttings in centimeters, 15-1, 15-2, 15-3, 30-1, etc.

One hundred cuttings were prepared for each size, for each of the three species. That is, 600 cuttings of *D. elliptica,* 600 of *D. polyantha,* and 600 of *D. philippinensis* were prepared at each planting time.

Arrangement and planting in the field

For convenience and proper understanding of the arrangement of plots see planting plans.

Cuttings were prepared one or two days before planting. They were planted in the holes at an angle of approximately 45° with the surface of the ground. About two-thirds of the cutting was buried in the soil and properly covered, taking care not to rub off the buds nor invert the cutting. The soil around each cutting was slightly pressed with the foot to make it more compact. The pieces were cut and planted without any special treatment, such as coating the cut surface with coal tar to prevent rapid evaporation of moisture from the cuttings.

After planting, practically no care was given to the cuttings except occasional weeding to prevent them from being overgrown.

OBSERVATIONS AND RESULTS

Eleven monthly plantings were made from February to December, 1934. The first four plantings were made in an open field, and the other seven in a field under some forest trees.

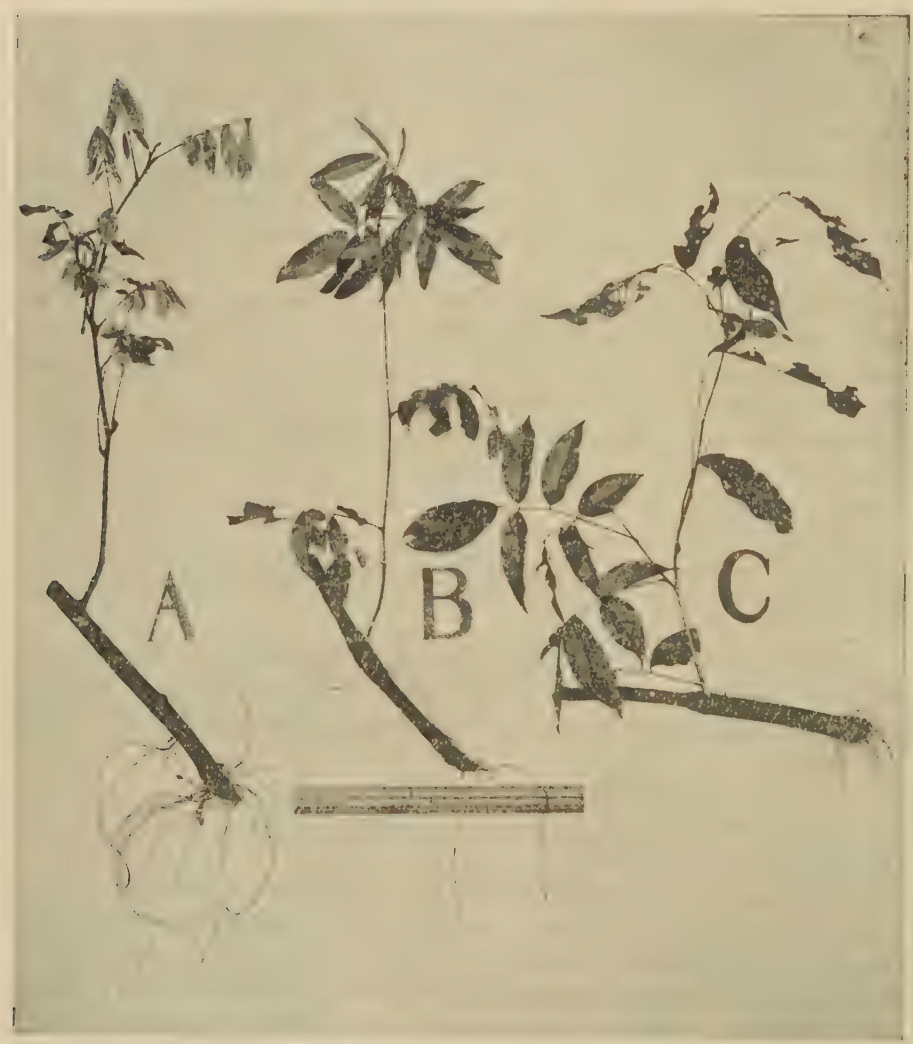


Fig. 1.—Six months old cuttings. (*A*) *D. elliptica;* (*B*) *D. polyantha;* (*C*) *D. philippinensis.* Note the habit of growth and root formation of each species.

Weekly observations on the condition of all planted cuttings were made. At the close of the experiment on January 14, 1935, a final count was made, noting the number of cuttings which had developed shoots, and those which were still green or dead. Photographs of plants six months old and one year old are shown in figures 1, 2 and 3.

To determine the approximate size of cuttings for commercial planting and the percentage of sprouting of cuttings planted in different months, the following criteria were used:

Green. The number of green cuttings were noted at each observation. Those that were fresh in appearance with no sign of drying or wilting and those which upon removal of the outermost layer of the bark (cork) showed green pigment were considered green and living at the time of the field observation.

Sprouted cuttings. Cuttings that had sent out shoots were also noted. The young shoot buds first appeared as tiny knobs on the nodes. Later, they elongated and formed the pinnate leaves. At the time the buds appeared as tiny knobs, the cuttings were considered sprouted.

Dead cuttings. The dead cuttings were characterized by the whitish, somewhat powdery growth of fungus on them. The bark became wrinkled, and could easily be separated from the woody portion.

The results of the experiment are shown in tables 1 to 4 and charts 1 and 2.

Weekly observations on the conditions of the different sizes of cuttings in the eleven sets of plantings were made. The percentages of cuttings that were green, dead or sprouted at the end of four weeks were determined. Table 1 shows the mean percentage of sprouting of the different sizes in the three species of *Derris* studied. Table 2 shows the comparison between the different sizes of cuttings and table 3 the comparison between the three species studied.

Chart 1 shows in the eleven sets of plantings the percentages of shoot formation at the end of four weeks; chart 2, at the close of the experiment.

DISCUSSION OF RESULTS

Monthly planting

Mortality of the cuttings. Different sizes of *Derris* cuttings planted in different months showed different percentages of sprouting. This difference may be explained by the variations in the amount of rainfall during each month.

Undoubtedly, the high mortality of the cuttings in February, March, and April and even in May was due to the light rainfall during those months, together with a comparatively high temperature.

Unfortunately climatological data for February and March were not available, but personal observation was that during these months in 1934 there was very little rain. Of the plantings during March and April, the percentage of mortality ranged from 84 to 97 per cent in the case of *D. elliptica*, 76 to 100 per cent for *D. polyantha*, and 87 to 100 per cent for *D. philippinensis*. The average weekly mean temperature in the fourth week in March was 29.9°C. with a total rainfall of 120 millimeters. The average weekly mean temperature in April was 30.4°C. with a rainfall of 861 millimeters which occurred rather late in the fourth week. There was no rain in the first three weeks in the April planting. In the May planting, however, lower percentages of mortality of the cuttings than in the preceding months were recorded. The rainfall during May was heavier than in the previous months, but the temperature remained high. This high temperature may account for a few cuttings being alive at the end of the fourth week. In the succeeding months a slight decrease in the mortality of the cuttings was noted, owing probably to the fairly uniform rainfall. This was observed in the planting in August. A total weekly rainfall of 1,015 millimeters was recorded in the second week after planting and the average weekly mean temperature was 34.1°C. in the fourth week, which was rather high for the survival of the cuttings. There was a range of from 42 to 97 per cent mortality at the end of the fourth week. In all plantings, *D. philippinensis* and *D. polyantha* suffered the most

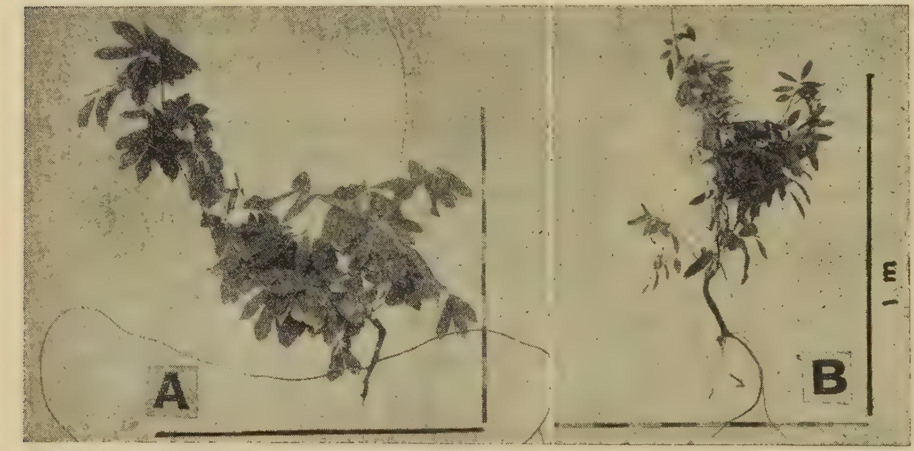


Fig. 2.—One year old cuttings. (*A*) *D. elliptica;* (*B*) *D. polyantha.* Note habit of growth and root formation. The lines, both perpendicular and horizontal, each 1 meter in length, show the size of the plants.

from the effects of the drought. It was observed that *D. elliptica* cuttings invariably exuded a waxy, reddish substance at the cut ends. This substance formed a cover on the wood and bark regions, thus reducing, to a certain extent, moisture evaporation from the cuttings. This protection may account for the high percentage of sprouting in *D. elliptica*, as was recorded at the end of eleven months. The results are given in table 4. The other two species showed no indication of this characteristic wax formation, consequently the cut ends were exposed to the direct effect of the surrounding atmosphere. Because of the absence of the exudate, it is probable that evaporation from the cuttings of *D. philippinensis* and *D. polyantha* was greater than moisture evaporation from the cuttings of *D. elliptica*.

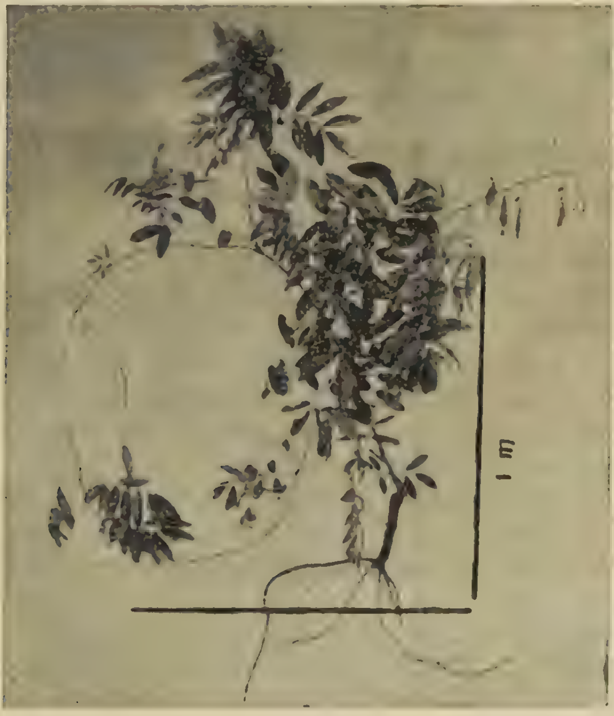


Fig. 3.—One year old cutting of *D. philippinensis*. Note habit of growth and root formation. The lines both horizontal and perpendicular, each 1 meter in length, show the size of the plant.

Sprouting. The percentages of sprouted cuttings, the records of rainfall, temperature and relative humidity were analyzed. It was found that plantings made during February, March, April and May gave low percentages of sprouted cuttings, but the sprouting gradually increased in the succeeding months. Of the three species of *Derris* studied, *D. elliptica* gave the highest percentage of sprouting.

The length of time necessary for the cuttings to produce shoots was found to vary considerably. It took from one to several weeks before shoots were formed in all species. In general, more cuttings from *D. elliptica* and *D. philippinensis* formed shoots than from *D. polyantha.* This difference was observed in the October, November and December plantings. During these months practically no shoots sprouted within the first four weeks from cuttings of *D. polyantha.* The cuttings, 30 centimeters long and 2 centimeters in diameter of *D. elliptica,* planted in November had a sprouting percentage of 42. In the December planting of *D. elliptica,* 41 per cent sprouting was noted in cuttings 30 centimeters long with 1 centimeter diameter; cuttings of similar size from *D. polyantha* failed to produce shoots. With *D. philippinensis* only 1 per cent of the cuttings with the same length and diameter sprouted.

It was observed that the cuttings that produced shoots finally died or wilted. Upon a close examination of these dead cuttings it was found that very few roots had formed, and they were very small in proportion to the shoots. Such cuttings are shown in figure 4. The death of these cuttings may perhaps be attributed to insufficient absorption of water from the soil.

Observations were made at the end of four weeks and plotted in chart 1. It was observed that a low percentage of the cuttings planted in February, March, April and May remained green for a period of four weeks. Also, only a low percentage of the cuttings planted had sprouted at the end of that period; most of the cuttings had died. In the succeeding plantings higher percentages of green cuttings were noted, especially in September, October, November, and December. As high as 92 per cent was recorded in December for *D. elliptica,* in cuttings 15 centimeters long and 3 centimeters in diameter. In November plantings of *D. polyantha* 100 per cent of the cuttings measuring 30 centimeters long and 2 centimeters in diameter remained green for four weeks.

Shoot formation was very much delayed in *D. polyantha* and *D. philippinensis* cuttings, planted during October, November and December. There were comparatively lower percentages of dead cuttings during these three months than in the preceding eight. The rainfall, in general, was observed to be uniformly high from October to December.

The percentages of sprouted cuttings at the end of the fourth week were plotted and are presented in chart 1. The relative percentages of sprouting in the three species increased gradually from May to September, but decreased from October to December. *Derris elliptica* had the highest percentage of sprouting; *D. philippinensis*, the second highest, and *D. polyantha*, the lowest. At the end of four weeks the relatively high percentages of sprouting in the three species studied were found in September.

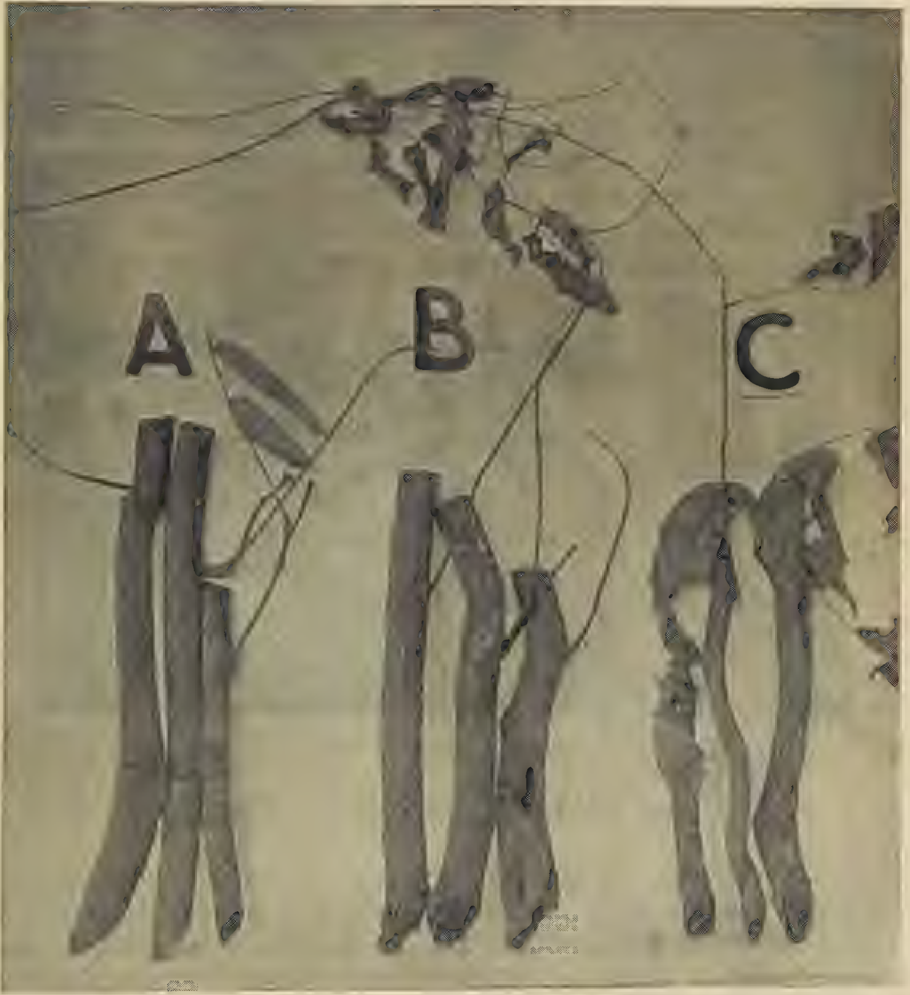


FIG. 4.—Showing cuttings which developed shoots but failed to form roots. (*A*) *D. elliptica;* (*B*) *D. polyantha;* (*C*) *D. philippinensis.*

The percentages of green, dead and sprouted cuttings were determined. It was noted that of the three species of *Derris* studied, *D. elliptica* gave in all the sizes used the highest percentages of sprouting. But a low percentage of sprouting was observed from February to May, and a high percentage from June to December in *D. elliptica.*

Chart 2 shows the graphical representation of the total percentages of shoot formation at the close of the experiment. It may be seen in this chart that *D. elliptica* showed the highest relative percentages in the month of September. The average percentage of shoot formation for all sizes was 38.3 per cent in *D. elliptica,* 27.3 per cent in *D. philippinensis* and only 21.8 per cent in *D. polyantha.*

Table 4 records the average percentage of shoot formation after four weeks and at the close of the experiment in the open and in the shaded fields. It may be seen that in the open field not all cuttings which produced shoots after the fourth week continued to live. In all the cuttings used a lower percentage of shoot formation was found at the end of eleven months than in those observed after four weeks. This was especially true in the open field but, with few exceptions, was not in the shaded field. In *D. elliptica,* for example, the cuttings 15 centimeters long and 3 centimeters in diameter showed at the close of the experiment shoot formation better than at the end of the fourth week. Also, in *D. philippinensis* increases were noted in the cuttings 15 centimeters long, and 1 and 3 centimeters in diameter as well as in those 30 centimeters long with

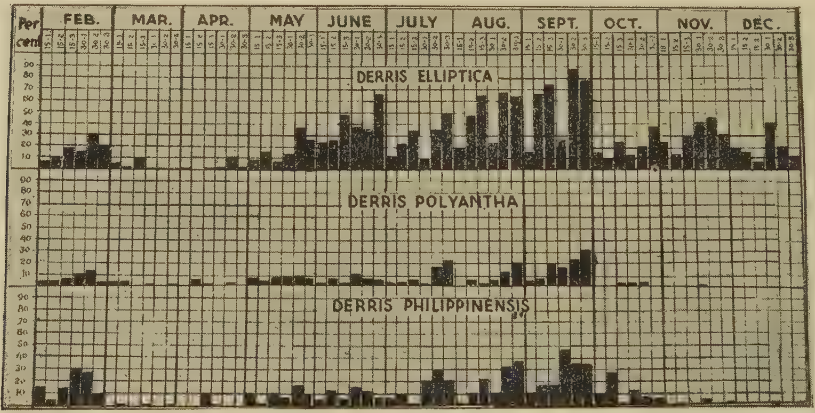


Chart 1.—Showing the total percentages of shoot formation at the end of four weeks from planting in the three species of *Derris* studied. Data plotted in this chart were taken from table 4 which is not included in this paper but is on file in the Department of Agronomy.

3 centimeters diameter. In *D. polyantha* all the cuttings found with shoots at the end of four weeks had increased the number of shoots formed at the end of eleven months, with the exception of cuttings 30 centimeters long and 3 centimeters in diameter. These results seem to show that some cuttings of *Derris* in the shaded field which had not formed shoots four weeks after planting developed new shoots later. But some cuttings that formed shoots within the same period died later. Photographs of cuttings which produced shoots but failed to form roots are shown in figure 4. Some of the leaves had fallen off from the cuttings, and some were beginning to wilt.

Sizes of cuttings for planting

To determine the approximate size of cuttings for planting, the mean percentages of sprouting in the different sizes at the close of the experiment were computed. The results are presented in table 1. It may be seen in this table that the highest mean percentage obtained in *D. elliptica* was 31.45 ± 5.71 from the cuttings 15 centimeters long and 3 centimeters in diameter. The lowest mean percentage of sprouting was 10.45 ± 1.21 in the cuttings 15 centimeters long and 1 centimeter in diameter. In *D. polyantha* the highest mean was 7.18 ± 2.51 per cent in the cuttings 30 centimeters long and 3 centimeters in diameter, and the lowest, 2.54 ± 0.61 with those 15 centimeters long and 2 centimeters in diameter. In *D. philippinensis* the highest mean obtained was 10.09 ± 2.58 from cuttings 30 centimeters long and 1 centimeter in diameter, and the lowest was

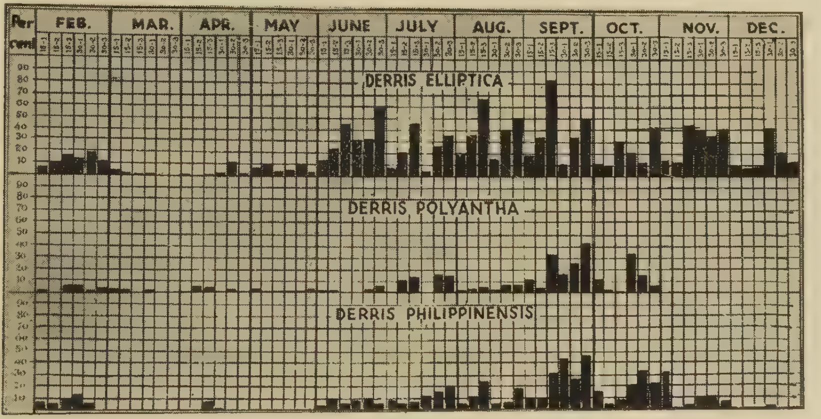


Chart 2.—Showing the total percentages of shoot formation at the close of the experiment in the three species of *Derris* studied. The data plotted in this chart were taken from table 5 which is not included in this paper but is on file in the Department of Agronomy.

found to be 4.09 ± 0.99 in those 15 centimeters long and 2 centimeters in diameter.

Comparisons among the different sizes of cuttings in each species were made. These comparisons are shown in table 2. Using the mean percentage of sprouting in cuttings 15 centimeters long and 3 centimeters in diameter as a basis for comparison, no significant difference was found between the different sizes of cuttings from *D. elliptica,* except between the cuttings of 15 centimeters long and 1 centimeter in diameter, and those of 15 centimeters and 3 centimeters in diameter. The difference between the two means of percentage of sprouting was found to be 21.00 ± 5.84 per cent. In *D. polyantha* and *D. philippinensis,* however, there was no significant difference found in the sizes compared. Cuttings measuring 15 centimeters long and 3 centimeters in diameter of *D. elliptica* gave the highest mean percentage of sprouting. This was found to be 31.45 ± 5.71 per cent. In the case of *D. polyantha* and *D. philippinensis,* no particular size was found to be better than another. Charts 1 and 2 show that these two species have lower percentages of sprouting than *D. elliptica.*

Comparisons of the highest mean percentage of sprouting in the three species are shown in table 3. Comparing *D. elliptica* and *D. polyantha,* the first was 24.27 ± 0.64 per cent better than the second, a significant difference. When *D. elliptica* and *D. philippinensis* were compared a significant difference of 21.36 ± 0.27 was obtained. But comparing *D. philippinensis* and *D. polyantha* no marked difference was found, it being 2.91 ± 3.60.

As regards the sprouting ability of the different cuttings used, *D. elliptica* gave better results than either of the other two species of *Derris* studied; *D. philippinensis* was not any better than *D. polyantha.*

SUMMARY AND CONCLUSIONS

1. Cuttings of *Derris elliptica* (Roxb.) Benth., *D. polyantha* Perk., and *D. philippinensis* Merr. were planted monthly under field conditions.

2. Six different sizes of cuttings were used. They were: (1) 15 centimeters long and 1 centimeter in diameter, (2) 15 centimeters long and 2 centimeters in diameter, (3) 15 centimeters long and 3 centimeters in diameter, (4) 30 centimeters long and 1 centimeter in diameter, (5) 30 centimeters long and 2 centimeters in diameter, and (6) 30 centimeters long and 3 centimeters in diameter.

3. It was found that plantings in all three species during the comparatively hot months of February, March, April, and May showed a relatively low percentage of sprouting.

4. There was a gradual increase in the relative percentages of sprouting from June to September, but a decrease was noticed from October to December.

5. The highest relative percentages, at the end of four weeks from planting, of shoot formation was found in September.

6. Some cuttings which had not sprouted at the end of four weeks sprouted later and formed roots. On the other hand, some cuttings which produced shoots within four weeks died later because of their inability to produce roots.

7. The mean percentage of sprouting in *D. elliptica* ranged from 10.45 ± 1.21 to 31.45 ± 5.71. In *D. polyantha* the range was from 2.54 ± 0.61 to 7.18 ± 22.51 per cent and in *D. philippinensis* from 4.09 ± 0.99 to 10.09 ± 2.58 per cent.

8. The cuttings 15 centimeters long and 3 centimeters in diameter gave the highest mean percentages of sprouting in *D. elliptica.* Cuttings that were 30 centimeters long and 3 centimeters in diameter gave the highest mean percentage in *D. polyantha.* And cuttings that were 30 centimeters long and 1 centimeter in diameter gave the highest mean percentage in *D. philippinensis.*

9. For propagation purposes the different sizes of cuttings studied in *D. elliptica* seemed to be as good as those 15 centimeters long and 3 centimeters in diameter; the cuttings 15 centimeters long and 1 centimeter in diameter at the end of eleven months gave the lowest mean percentage of sprouting. In *D. polyantha* and *D. philippinensis,* however, all the sizes generally gave low results.

10. In all sizes of cuttings *D. elliptica* gave higher mean percentages of sprouting than either of the other two species.

11. The mean percentages of shoot formation obtained under field conditions described in this paper were rather low in the different sizes of cuttings in the three species of *Derris* used.

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TABLE 1

Showing the mean percentages of sprouting of the different sizes in the three species of Derris

SIZE OF CUTTING	MEANS		
	D. elliptica	*D. polyantha*	*D. philippinensis*
	per cent	*per cent*	*per cent*
15-1	10.45 ± 1.21	2.90 ± 0.84	7.27 ± 1.84
15-2	14.72 ± 2.44	2.54 ± 0.61	4.09 ± 0.99
15-3	31.45 ± 5.71[a]	5.36 ± 1.97	8.45 ± 5.79
30-1	16.63 ± 2.98	5.27 ± 2.08	10.09 ± 2.58[a]
30-2	21.91 ± 2.61	6.00 ± 1.73	9.54 ± 2.23
30-3	27.82 ± 4.56	7.18 ± 2.51[a]	9.90 ± 2.92

[a] Highest mean used as basis for comparison.

TABLE 2

Showing comparison among different sizes in the same species

DERRIS SPECIES	SIZES COMPARED	DIFFERENCES	VALUE OF DIFFERENCE
		per cent	
D. elliptica	15-3[a] — 15-1	21.00 ± 5.84	Significant
	15-3 — 15-2	16.73 ± 6.21	Insignificant
	15-3 — 30-1	14.82 ± 6.44	"
	15-3 — 30-2	9.54 ± 6.28	"
	15-3 — 30-3	3.63 ± 7.78	"
D. polyantha	30-3[a] — 15-1	4.28 ± 2.65	Insignificant
	30-3 — 15-2	4.64 ± 2.59	"
	30-3 — 15-3	1.82 ± 3.19	"
	30-3 — 30-1	1.91 ± 3.26	"
	30-3 — 30-2	1.18 ± 3.65	"
D. philippinensis	30-1[a] — 15-1	2.82 ± 3.17	Insignificant
	30-1 — 15-2	6.00 ± 2.76	"
	30-1 — 15-3	1.64 ± 6.34	"
	30-1 — 30-2	0.55 ± 3.41	"
	30-1 — 30-3	0.19 ± 3.89	"

[a] Size of cutting with highest mean used as basis for comparison.

TABLE 3

Showing the comparison between the highest means of the three species of Derris

SPECIES COMPARED	DIFFERENCE	VALUE OF DIFFERENCE
	per cent	
Ellip.[a] — Pol.[b]	24.27 ± 0.64	Significant
Ellip. — Phil.[c]	21.36 ± 0.27	Significant
Phil. — Pol.	2.91 ± 3.60	Insignificant

[a] Highest mean of *D. elliptica*

[b] Highest mean of *D. polyantha*

[c] Highest mean of *D. philippinensis*

TABLE 4

Average percentage of shoot formation after four weeks and at the close of the experiment in the open and shaded fields

Open field

SIZE OF CUTTINGS		D. ELLIPTICA WITH SHOOTS AFTER		D. POLYANTHA WITH SHOOTS AFTER		D. PHILIPPINENSIS WITH SHOOTS AFTER	
Length	Diameter	four weeks	eleven months	four weeks	eleven months	four weeks	eleven months
cm.	*cm.*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
15	1	5.50	4.75	3.50	1.75	6.50	2.00
15	2	6.75	5.25	4.00	1.75	2.25	1.50
15	3	9.75	5.50	3.50	2.25	9.00	4.25
30	1	8.00	5.25	4.75	1.75	10.00	3.50
30	2	19.75	10.00	7.50	1.00	11.50	1.75
30	3	12.25	4.00	2.75	1.00	5.25	0.00
Under trees							
15	1	18.57	13.71	1.42	3.55	4.87	10.28
15	2	28.71	20.14	3.00	3.00	11.14	5.57
15	3	40.28	46.28	4.57	7.14	10.00	10.85
30	1	27.71	23.14	5.28	7.28	15.85	13.85
30	2	46.42	28.71	8.43	8.85	16.43	14.00
30	3	45.87	41.42	10.85	10.71	15.00	16.28

ABSTRACTS [1]

A comparative test of ratoon canes of some promising College seedlings and two commercial varieties of sugar cane in the College of Agriculture. JULITO MARCOS. (*Thesis presented for graduation, 1933, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 484; Experiment Station contribution No. 1104*).—There were 40 promising P.B. (Plant Breeding) cane varieties used. The two commercial varieties, M-1900 and Luzon White, were used as control. These varieties were planted March, 1930 and the first crop was harvested 11 months after planting. The field was burned over after the sugar cane tops were dry. After the first rain in May off-barring was done, and two weeks later the cane was hilled-up.

A month after burning there were 12 P.B. canes that gave 100 per cent of living stools. These varieties were: P.B. 402; R-7 (P.B. unknown); P.B. 295; P.B. 389; P.B. 361; P.B. 408; P.B. 369; P.B. 297; P.B. 403; P.B. 214; P.B. 282; and P.B. 176. The control varieties gave 83.45 per cent for Luzon White and 93.60 per cent for M-1900 of living stools. Some of the stools of the control varieties had not germinated a month after burning, which showed that they were poor ratooning varieties.

It was noted that of the 12 varieties of P.B. canes which had 100 per cent germination, only one P.B. cane variety, (P.B. 402), reached 100 per cent stools at maturity. In addition to the one P.B. cane variety which gave 100 per cent of stools at maturity, P.B. 407 which had 85.29 per cent germination and P.B. 292, 94.91 per cent germination gave 100 per cent of stools at maturity. The rest which gave over 90 per cent stools at maturity but below 99 per cent were: P.B. 355; R-7 (P.B. Unknown); R-125 (P.B. Unknown); P.B. 295; P.B. 389; P.B. 356; P.B. 351; P.B. 357; P.B. 340; P.B. 360; P.B. 361; P.B. 312 and P.B. 367. Comparing the living stools of the P.B. canes that reached maturity with the control, there were 36 seedlings that gave higher percentage than M-900 and 35 that gave higher percentage than Luzon White.

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[1] Abstracts prepared as part of required theme work in English 3a, College of Agriculture.

Most of the P.B. seedling canes were taller than the control, M-1900 or Luzon White. The P.B. canes, P.B. 274; R-7 (P.B. Unknown); P.B. 402; P.B. 280; and P.B. 282, were better stoolers and gave much heavier millable stalks per stool than the control varieties.

P.B. 277 and P.B. 406 gave a higher per cent apparent purity than M-1900, but M-1900 gave the highest percentage of polarization of the varieties tested. The seedlings that gave over 90 per cent purity were: P.B. 351; R-125 (P.B. Unknown); P.B. 297; P.B. 282; P.B. 252; and P.B. 329. Luzon White gave only 88.81 per cent. Variety M-1900, although lower in purity than P.B. 406 or P.B. 277, had the best quality ratio, and the highest piculs of sugar per ton of canes because the seedling canes (P.B. 406 and P.B. 277) were pithy.

The seedlings which gave more than 2 piculs of sugar per ton cane were: R-125 (P.B. Unknown); P.B. 297; P.B. 351; P.B. 366; P.B. 277 and P.B. 406. M-1900 gave 2.34 piculs of sugar per ton cane, the highest, and Luzon White the lowest, 1.85 piculs of sugar.

M-1900 variety gave an average yield per hectare of 9.12 tons cane or 21.35 piculs sugar, and Luzon White, 19.07 tons cane or 35.28 piculs sugar. The P.B. seedlings which gave more than 60 tons of cane and from 110 to 168.49 piculs of sugar per hectare were: P.B. 282; P.B. 361; P.B. 407; P.B. 344; P.B. 369; P.B. 360; and P.B. 395.

The promising canes at first ratoon which yielded an average of 90.79 piculs of sugar per hectare were: P.B. 282; P.B. 361; P.B. 407; P.B. 297; P.B. 344; P.B. 369; P.B. 406; P.B. 329; P.B. 349; P.B. 360; P.B. 355; R-125 (P.B. Unknown); P.B. 335 and P.B. 395.

The seedling canes, which in spite of attack by disease yielded the highest number of tons of canes or piculs of sugar per hectare were: P.B. 282; P.B. 407 and P.B. 297.

The results may be summarized as follows:

1. The seedling canes which gave higher tonnage and piculs of sugar per hectare in the plant cane than in the ratoon were: P.B. 335; P.B. 395; P.B. 403 and P.B. 331.

2. There were seven seedling canes which gave high tonnage in the ratoon crop: P.B. 282; P.B. 407; P.B. 344; P.B. 406; P.B. 360; R-125 (P.B. Unknown); and P.B. 292.

3. There were six seedlings which gave more piculs of sugar in the ratoon than in the plant crop: P.B. 282; P.B. 407; P.B. 344; P.B. 369; P.B. 406, and R-125 (P.B. Unknown).

4. M-1900 and Luzon White gave a higher tonnage and more piculs of sugar in the plant cane than in the ratoon, which shows that they are poor ratooners.

5. Most of the P.B. canes (P.B. 282, P.B. 361; P.B. 407; P.B. 297; and P.B. 344) gave a higher tonnage and more piculs of sugar per hectare than M-1900 or Luzon White.

—*Abstract by M. P. del Puerto*

The variability in yield of individual coffee trees at the College of Agriculture. FELIX N. NATINO. (*Thesis presented for graduation, 1935, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 1105; Experiment Station contribution No. 485.*)—The object of this work was to study the variability in yield of fresh berries from 1925 to 1934 of all bearing coffee trees at the College of Agriculture, for the purpose of isolating the high yielding strains. The yield of the coffee trees from 1925 to 1931 was taken from the record books of the Permanent Crops Division. For 1932 to 1934 the author harvested the berries from the individual trees and weighed them separately.

The following types of coffee were used:

Liberian type, represented by *Coffea liberica* Hiern; and *C. excelsa* A. Chev., Robusta type, represented by *C. robusta* Linden, *C. quillou* and *C. canephora* Pierre.

The author summarized the results as follows:

1. There was a wide range of variation in the yield of fresh berries of the individual trees in the different varieties studied.

2. The range of variability in yield of individual trees varied with different varieties. In Excelsa, the range was from 10.1 to 9,032.5 grams; in Liberica, 20.1 to 6,700.7 grams; in Robusta, 5.1 to 7,360.0 grams; in Quillou, 10.1 to 5,708.0 grams and in Canephora, 9.6 to 2,425.5 grams.

3. The wide range of variation in the individual yield of trees within the variety provides a good basis for isolating the high yielding strains for commercial utility.

4. The mean of the average of the individual yields of the trees in the different varieties was as follows: Robusta, 1,044.70 grams; Quillou, 841.96 grams; Excelsa, 1,717.96 grams; Liberica, 2,905.02 grams; and Canephora, 598.29 grams. Trees giving a higher yield than the mean yield based on average of harvests for ten years may be considered good yielders.

5. The number of good yielding trees from each variety were: Robusta, 468 trees, representing 33.7 per cent of the trees in the Robusta plantation; Quillou, 174 trees, representing 36.9 per cent;

Excelsa, 47 trees, representing 30.3 per cent; Liberica, 36 trees, representing 56.2 per cent and Canephora, 15 trees, representing 29.4 per cent.

6. From these findings it is evident that on the basis of yield in fresh berries, not more than 50 per cent of the trees on the College coffee plantation should be used as sources of seed.

—Abstract by Aquilino V. Platon

CURRENT NOTES

On the Lindbergh Arctic flight in 1933, Colonel Lindbergh as arranged with Fred C. Meier, Senior Agriculturist, U. S. Department of Agriculture, trapped micro-flora in a spoon trap he devised. On his flights between the American mainland and Denmark by way of Greenland and Iceland Colonel Lindbergh exposed 26 slides and returned them to Mr. Meier with field notes and freehand maps and full data on time and conditions of the exposures.

On one slide exposed far north of the Arctic Circle, Mr. Meier was able to discover under the microscope more than 40 different types of objects in a space five centimeters square. This slide was exposed 3,000 feet above sea level.

"This Lindbergh collection" according to Mr. Meier, "is the first of its kind to give concrete evidence of the part played by air currents in the distribution of fungi between northern lands."

Condensed from *Science* January, 1935

When I was a child on a Western prairie my father, who was a banker in a small way, used to drive me around the countryside while he inspected farms whose owners desired to get mortgages.

It did not take me very long, when we drove up to a farm house, to know whether its owner would obtain the loan he wanted.

If the farm implements had been allowed to lie out on the ground, gathering rust, there was no argument. If they were kept under sheds, and remained free from rust, the farmer got his loan. . . .

My father used to say to me that a man who had a rusty harvester was pretty sure to have a rusty brain, and that a rusty brain meant ruin. JOHN BLAKE.

Manila Daily Bulletin.

Atebrin-musonat is a new preparation of atebrin, the important antimalarial drug introduced from Germany about three years ago writes the "News Chronicle" Medical Correspondent.

Atebrin is a synthetic chemical substance and was created in 1930 by the German dye industry at Elberfeld. It was first tested on birds infected with malaria.

The two drugs are widely used in place of quinine, but their exact advantages in particular types of infection have still to be ascertained. *News Chronicle 7, 3, 35.*

Reprinted in *The Planter*, April, 1935

Human beings became differentiated into races far back in man's history. It happened probably before the last Ice Age, and the cradle land of the races was Asia.

So anthropologists of the American Association for the Advancement of Science were told by Dr. Griffith Taylor of the University of Chicago.

He protested against the too-simple method of dividing men into three races, Caucasian, Mongol, and Negro, or, in effect, the white, yellow, and black. A more scientifically satisfactory classification is needed, he said, based on as many traits as possible, such as skin color, facial breadth, read index, hair, and stature.

Dr. Taylor has sugggested a classification of five major races of man: Negro, Mediterranea, Alpine, Negrito, and Australoid. Mongolians he places as a variant of the Alpine race.

Science News Letter, January, 1935.

We are told a good British hen keeps up a steady average of 100 eggs a year, with the record lay of 361 eggs in 364 days, which must have been a leap year. We are supposed to consume, we take it, in shell, 110 eggs a year, one home laid, one imported. Canada wants three times our number, say 330 eggs, per head, America 180, Belgium 213 in a year. . . . We pay Denmark £2,500,000 a year for eggs in shell, but to China goes our precious money to the tune of £600,000 for eggs in shell plus the cost of 23,000 tons of eggs out of their shell, i.e. dried, pulped, liquid, worth 6⅓d to 7d. per lb. How much does that come to? These 23,000 tons are reckoned to be equal to 750 million fresh eggs.

Tropical Life, June, 1935.

Village babies (in India) could be fed with water from boiled vegetables containing a little of the mashed vegetable, tomato juice, rice water containing salt, sugar and lemon (or lime) juice besides dal soup. . . .

In the U. S. A. where food values have been studied and tested to a great extent the proportion of vegetables eaten is high. . . .

In New York markets fresh vegetables and fresh fruit in the proportion of 1 lb. per person per day are sold.

In London the proportion is 4 oz. per person per day.

In Bombay the proportion is ½ oz. per person per day.

Study the death rate of the various countries and one can see vegetable and fruit diet adds to longevity.

The Allahabad Farmer, July, 1935.

COLLEGE AND ALUMNI NOTES

At the Convocation on December 7 former President Palma was one of the speakers. This was his first appearance at a convocation since his resignation. The prolonged and vigorous applause when he rose to speak must have warmed the cockles of his heart. After a strong, sound appeal for a sane earnest support of the Commonwealth, Doctor Palma introduced Mr. Frances Burton Harrison, Governor General of the Philippines from 1913 to 1921. Governor Harrison spoke briefly and graciously of his confidence in the success of the new government. Dean Gonzalez in introducing Doctor Palma brought in some past facts and future hopes related to the College with a sincere though light touch. Doctor Manresa as Chairman of the Committee of Social Affairs opened the convocation with "felicitous" remarks. After the convocation, Doctor Palma and Governor and Mrs. Harrison were entertained at luncheon at Molawin Hall by a group of faculty members.

On November 26, 1935, the students in Home Economics of the College of Education, U. P. under Mrs. Alicia Palma-Bautista visited the Food and Nutrition laboratories of the Department of Agricultural Chemistry. Dr. F. O. Santos, by request addressed the group on Filipino foods.

In the meeting of the Board of Regents of the University of the Philippines held November 13, 1935, Dr. F. O. Santos, Professor and

Head, Department of Agricultural Chemistry was appointed Professorial Lecturer in Chemical Hygiene and Nutrition in the School of Hygiene and Public Health.

The one-hundred-and-eighth regular scientific meeting of the Los Baños Biological Club was held in the Lecture Hall of the Plant Physiology Building, College of Agriculture, December 5, 1935, at 7:30 o'clock in the evening.

The following papers were read and discussed:

1. "The use of inarching to improve rate of propagation by grafting and marcottage." By Dr. L. G. Gonzalez.
2. "Preliminary line-plot system in the culled Dipterocarp forest, Maquiling National Park". By Mr. Justino Seguerra.

Ten neophytes were admitted into the fold of the Rizal Center Fraternity on Friday, November 27 after they had pledged with 'their heads, their hearts and their hands' to uphold the honor system not only in the pursuit of their studies but also in all dealings with their fellowmen; an undivided and untainted loyalty to the Alma Mater and to strive for high scholarship and disinterested service to society. The new fraters are Professors Nicolas Galvez, Felipe Salvoza, Jose Velmonte and Messrs. Proceso Alcala, Ricardo Buhay, Esteban Cada, Jose Luna, Cecilio Pangga, Gabino Rotor and Lorenzo Zialcita.

The group met at Molawin Hall after the initiation for the customary celebration supper given by the new members.

The Rizal Center Fraternity is the oldest and largest chapter in the U. P., as the Los Baños Chapter was organized in 1921.

The Cosmopolitan Club of the Los Baños Colleges held its first recognized meeting on the evening of December 6 in the English Building. The club is composed of 21 students from Siam, 10 students from China, 3 students from Dutch East Indies, 1 student from Sarawak, 1 student from India, and 12 students of the Philippines.

At this meeting officers and honorary members for the semester were elected. The officers are: President, M. Effendi Siregar; Vice-President, Tong-yu Stringer; and Secretary-Treasurer, Miss Lourdes

Dawis. Ten honorary members were chosen. They are: Dean Gonzalez, Professors Yule, Manresa, Mabbun, De Leon, Villegas, Salvoza, Fronda, Cole, and Buhay. Doctor Fronda from this group was elected Adviser.

After the meeting a very interesting and instructive paper on Siam marriage customs was read by Sangtod Bukkavesa. After reading his paper he exhibited some Siamese metal work and other products.

This club was formed with the serious purpose of fostering closer relationship and better understanding among the students of the various nationalities represented on the Campus.

At the January meeting a Chinese will present a paper on some Chinese subject.

This club has the honor of being the first cosmopolitan organization in the University of the Philippines. A club along these lines has been urged by the members of the English staff in this College for a number of years, but it was not until May, 1935 that enough interest could be aroused to begin the work of organizing.

The organization work was carried out with the aid of Assistant Professor Anne F. Cole of the English Department. Official recognition was obtained in November. The charter members are:

China

Miss Helen Au-Yeung
Chan Min Sang
Chau Kin
Miss Cheung Sui Fong
Kwan Tai Wai
Miss Lee Pao Shan
Pang Kwock Kee
So Tso Yum
Wong Shin Yan
Wong Tok Shan

Dutch East Indies

Lim Gwan Tiong
Moechtar Effendi-Siregar
Radam Soehadi

India

Kesava Pillai Nilacanta

Philippines

Lorenzo Balasoto
Lourdes Dawis
Gabriel Flores
Rasuman Macalandong
Domingo Madrid
Pedro Malang
Miguel Manresa Jr.
Celestino Quilang

Sarawak

William Crocker

Siam

Sangtod Bukkavesa
Saluey Emasiri
Abhai Isarabhakdi
Kan Jalavicharana
Phatanana Lampoon
Rathadarana Lampoon
Odd Janlekha
M. R. Arohitta Kashamsri
Ian Khambanonkha
Bhakdi Lusananda
Arth Nakornthap
Prassert Na Nakara
Vallabha Naraballabha
Chalam Natatat
Pradip Pradipasen
Praduang Pradipasen
Krui Punyasingh
Xom Raktakanistha
Aroon Songmani
Augustine T. Springer
Sangad Sukhputra

Miguel de Guzman, a Junior has left College to accept a position as manager of the poultry, swine and truck garden enterprises of Hijo de J. de la Rama in Iloilo.

The Senior Sugar Technology students, as required in the course, are all out in different Sugar Centrals for mill practice this semester. The assignments are as follows:

1. Jose C. Atienza	Ormoc Sugar Company Ormoc, Leyte
2. Alfredo A. Agdeppa	Central Azucarera de Tarlac San Miguel, Tarlac
3. Jose E. Borromeo	Central Azucarera Don Pedro Nasugbu, Batangas
4. Marcial V. Enriquez	San Carlos Milling Company San Carlos, Occ. Negros
5. Francisco R. Lopez	Ormoc Sugar Company Ormoc, Leyte
6. Consorcio V. Manuel	Hawaiian-Philippine Company Silay, Occ. Negros
7. Teodoro C. Megia	Pampanga Sugar Development Co. San Fernando, Pampanga
8. Nelson T. Regalado	Ma-ao Sugar Central Company Bago, Occ. Negros

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On the evening of November 27, 1935, at Center, the Mimics presented two one-act plays:

"The Noble Lord"—by Percival Wilde

He	Andres Caranto
She	Leona Atienza-Dacanay
Peters	Celestino Quilang

The scene was laid in the Maine Woods during the fashionable Summer Season.

"Please Pass the Cream"—by Charles Holmes

Mr. John Clark	Concordio Mandac
Mrs. John Clark	Lina Velmonte

Time—Breakfast

Both plays are comedy, the humor lying largely in the lines. The Director, Professor Anne Cole and the actors are to be complimented on the "finished presentation". The College Orchestra added to the pleasure of the audience with three selections. The "Commonwealth March" by Borromeo deserves special words of praise—both the composer and the orchestra. It is a splendid, melodious composition and was well played.

Error corrected: In the December issue of THE PHILIPPINE AGRICULTURIST in the report in this column on the Loyalty Day Celebration, the second place in Parade awards was credited through a mistake to School of Forestry. The Department of Agronomy was awarded second place and School of Forestry, Animal Husbandry and Rural High School received honorable mention.

It must be remembered that the purpose of education is not to fill the minds of students with facts; it is not to reform them, or amuse them, or make them expert technicians in any field. It is to teach them to think, if that is possible, and to think always for themselves. Democratic government rests on the notion that the citizens will think for themselves. It is of the highest importance that there should be some places where they can learn how to do it.—

PRESIDENT HUTCHINS.

What the Colleges Are Doing

The achievements of our own economic system have brought us new problems in stability in business, in agriculture, and in employment, and greater security of living. But the first contructive step in solution is the preservation of liberty, for in that sphere along are the dynamic forces with which to solve our problems successfully.

—HERBERT HOOVER.

I don't believe in kicking,
It does not make for peace,
But the wheel that does the squeaking
Is the wheel that gets the grease.

OURSELVES AS GULLIVERS IN THE LILLIPUTIAN WORLD OF THE INSECTS[1]

The hero in Swift's famous story was a somewhat unprepossessing person. He allowed himself to become bewildered by new or unusual experiences, apparently without profiting by them. But in seeing ourselves as Gullivers, such as we surely are in daily life, we need not suffer the humiliation of pitiable helplessness or of frustration. So overconfident are we, in fact, that we seldom give a thought to the general insecurity of our place in the earth's scheme of things. As Sir James Jeans cautions, "Man's success has come to him only yesterday in the history of the earth. He had to fight wild beasts, and man has not always prevailed. He must still fight for his position on earth. If man fails in his fight, he may be exterminated by smaller beings, perhaps by microbes."

Among our most serious contestants are the insects. We frequently overlook them because of their small size, but it is the advantage of small size that to a large extent constitutes the insects' strength. For one thing, a tiny bit of an insect requires but a small fraction of the food required by the comparative giants among the ordinary run of man and of lower animals. When we consider that the food problem is most frequently a determining factor in survival, we can readily appreciate how successfully insects have been able to overcome this hindrance to increase and development. In fact, insects have gone one jump ahead: they have learned to utilize as food material that which other animals are incapable of eating. What is more amazing, for instance than the termites, or anay, deriving their entire nourishment from ordinary cellulose, the substance in wood, which is the most abundant of organic materials, but which neither you nor I can live on? Excreta, bacteria, fungi, cadavers, fellow insects, and a host of other substances may make up an insect's daily fare. Shakspeare must have had the insects in mind when he wrote in *Antony and Cleopatra*—

> "It is reported thou didst eat strange flesh
> Which some didst die to look on."

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[1] General contribution from the College of Agriculture No. 519. This paper was broadcast from Station K Z R M, Radio Manila, January 4, 1936, as part of the University of the Philippines Educational Program.

PHILIPPINE AGRICULTURIST, VOL. XXIV, NO. 10, MARCH, 1936

Ordinarily, it takes insects only a few days to rear a new brood. Many of our insects go through as many generations in one year's time as the human species through three long centuries. Combined with the fact that a mother insect frequently is able to produce eggs by the hundreds or even by the thousands, it is not surprising that insects become so ubiquitous. This increase, despite the fact that as a rule insect infant mortality is so high that but a small fraction of one per cent normally survives to the adult stage.

A high mortality rate is not the fault of insects. Mortality rate is high among all creatures in the wild. For that matter, an insect individual is relatively a most hardy animal. It goes through life encased in a strong armor of a hard chemical substance, called chitin, by which it is shielded from external injury and from disease germs. Even the breathing tubes, the digestive canal, large portions of the reproductive system, and many other internal organs, which we all know are among the weakest spots in our own bodies, are very effectively protected by the same material in insects. Hence, insects have not the equivalent of such devastating human diseases as tuberculosis, influenza, typhoid, smallpox, and other ills to which we are frequently subject. The secret of the chitin has continued to baffle chemists. They have so far failed to determine its exact chemical composition, much less to synthesize it in their laboratories. Likewise, certain characteristic products of insects, chemists have been able to imitate but rather poorly. Take silk, for instance. Silk is the strongest fiber known. It is a very poor conductor of heat and electricity, which makes it indispensable to the electrical and other industries. With the aid of huge, complicated machines, we have been able to duplicate the product of the lowly silkworm by producing a fiber that has the luster of silk but not its other properties. Another case is paper. To be sure, superior paper is produced in modern mills. But if we Gullivers had only been more observant of the ways of the paper wasp, modern history might have been pushed back several millenia and we might have been spared the trying labor of unravelling the secrets of ancient human civilizations from cuneiform inscriptions on heavy brick tablets. Certainly, it is not for nothing that astute King Solomon pronounced his counsel some thousands of years ago: "Go to the ant, thou sluggard, consider its ways and be wise."

Insects antedate man by eons on our planet. Because of their greater experience in the peculiar antics of this earth, they have developed habits and modes of life which it would do well for other living beings to follow if they only could. As Anatole France puts it, "If I had created man and woman, I should have made them on the model of those insects which, after a lifetime as caterpillars, change into butterflies and for the brief final term of their existence have no other thought but to love and be lovely. I should have set youth at the end of the human span."

It was the Greek writer Xenarchos who, doubtless in a spirit of envy, lamented, "Happy is the cicada, since its wife has no voice." In the Lilliputian insect world, however, and, in fact, even in the cicadas, the male is not the dominant sex that perhaps we Gullivers would have made it. For the all-important task of perpetuating the species, the male is often but an incidental element once in the entire life of the female. In certain cases, as in tropical aphids, males are unknown. In social insects, such as ants, bees, wasps, termites, and the like, the mainstay of the colony is always the female, and not the male. The fate of the male bee, or drone, after the brief nuptial flight, is quite a familiar feature in children's story books. As described in a most fascinating way by Dr. William Morton Wheeler, "The important difference [between human society and insect society] lies, I believe, in what I shall call the 'problem of the male,' which has been successfully solved by the social insects but not by mammal or human societies. . . . The termites keep only a single fully developed, monogamous male in the termitary and, as if confronted with a serious problem of male unemployment, have set upon the happy device of sterilizing most of the nymphs of this sex in their infancy and setting them to work with their equally sterile sisters in the kitchens, dining rooms and nurseries and at building and defending the termitary, instead of permitting them to sit around like a lot of social parasites and annoy the females. We may say that the termites are the only animals that have succeeded in completely socializing the males."

In this brief incursion into the peculiar ways of these tiny six-legged Lilliputians, we Gullivers get an insight into some of the numerous angles of their wonderful life. Lessons, indeed, they have a plenty for those of us who would pause and learn from them. But insects are infinitely more important to us than a mere subject for intellectual curiosity; they do affect us in a most profound way, in the toll they exact on agricultural crops, forests, our homes, furniture, books, clothing, public buildings, domestic animals, and even on our own person. It is difficult to translate in terms of pesos the losses we in the Philippines suffer every year from the work of this relentless foe; they easily mount up to over 200 millions. The ear-marks of their depredations are found everywhere man tries to carry on his life's activities. Virgil might well have dedicated to insects the following lines from the *Aeneid*:

> "Swiftly they cleave
> The air, and leave their filthy tracks behind
> On the half-eaten banquet."

And, of course, the humiliating part is that all that we Gullivers get is the left-over. Moreover, agricultural and industrial practices often create altered conditions in favor of our insect enemies, especially in the way of increasing their food supply.

The Philippines, located as it is at the crossroads of three of the world's great centers of distribution of plant and animal life, possesses an exceptionally rich insect fauna. It is estimated that, while other islands as Hawaii have only some two thousand species of insects, the Philippines has between twenty and thirty thousand species or more. Approximately one-half of this number consists of beetles and weevils. Butterflies, moths, skippers, ants, bees, wasps, flies, gnats, midges, mosquitoes, true bugs, plant lice, cicadas, leafhoppers, scale insects, grasshoppers, locusts, walking sticks, leaf insects, crickets, cockroaches, and the like are also abundant.

Altogether insects represent some 70 per cent of all kinds of animals. Every insect species vies with the others in resourcefulness and in ability to overcome difficult situations. Plantfeeding insects, which make up approximately one-half of our insect species, give us trouble when their food happens to include cultivated plants or valuable forest trees. The Filipino farmer would have had some ten or fifteen thousand kinds of insect enemies if all of our approximately eight thousand species of flowering plants were cultivated plants. As it is, cultivated plants in the Philippines number only about three hundred species, of which barely a hundred are actually useful. The number of insect species that have an appetite developed for these relatively much fewer kinds of plants is thus correspondingly narrowed to about five hundred, some one-third of which consists of moths, skippers, and butterflies. Even this depleted number in the enemy ranks, however, is constantly giving Philippine agriculture grave concern. To make matters worse, we have to admit that we know very little about our insects, and this lack of adequate information often proves disastrous, because it leaves us at the mercy of sudden invasions.

Warfare with insects is, indeed, a real warfare, and it is, therefore, not unlike any other kind of warfare. It needs for its successful prosecution adequately manned intelligence forces to collect all the essential data and determine where the enemy lines are weakest or where and how our offensive might be directed in order to deal a telling blow. The enemy we have to contend with is not just an ordinary kind of enemy. It outnumbers us by millions to our one, all the units vigorously carrying on with an ability that is almost uncanny an insidious attack in twenty-four hour shifts. It is always ready to take full advantage of every false move we make. Our intelligence forces in this warfare, the entomological laboratories, are pitifully few and these woefully undermanned. The result is that we find our local entomologists overwhelmed with a multitude of problems, each demanding immediate attention. It is difficult to realize, unless one actually takes up the study of insects himself, how nearly impossible it would be under the circumstances to give more than superficial treatment to any but a few of these problems. Here is a serious situation, therefore, that insistently demands attention in this country. We must control the insects, otherwise these Lilliputian insects might soon have us Gullivers under control. We have at least three vital needs in order that we may more effectively strengthen our position in the battle-line: (1) We need more entomologists, so that more of our insect-pest questions may be studied with a degree of thoroughness that would be commensurate with their importance. We certainly are not lacking in competent men of high-class training for this kind of work in this country, but their training is unfortunately often wasted in other pursuits, owing to scarcity of entomological positions. It is a pity that this state of affairs should obtain, in view of the fact that preparation for an entomological career, as in other exacting callings, takes a number of years. Moreover, our experience at the College of Agriculture has been that many students either are unwilling to submit themselves to or have not the natural inclination for the arduous discipline connected with collegiate entomology. The few students, therefore, that elect entomology as major should be encouraged at least in the assurance of a fair chance to pursue their chosen vocation after they graduate. (2) Reënforcement of existing entomological laboratories by way of providing them with more adequate research facilities. Equipments necessary for precision in experimentation and observation, assistants, travel funds for purposes at least of checking up laboratory data with field conditions, reference libraries, and other essential requirements of an up-to-date scientific institution of this nature frequently entail expenses that add up to large sums of money; but these must be considered a good research investment, which in the long run should, if handled properly, be more than amply repaid in social dividends. (3) Co-ordination of the various scattered entomological agencies wherever feasible or desirable for more effective co-operation and in order to avoid dissipation of energy through unnecessary duplication of work. To some extent, steps toward this end have already been taken by the section of entomology and that of plant-pest and disease control of the National Research Council of the Philippine Islands. However, because the function of these two sections is almost purely advisory, co-ordination and co-operation has had to be left to the initiative and willingness of individual entomologists. Although it is generally admitted that scientific research is essentially individualistic, a closer-knit integration and perhaps better definition of the avowed official functions of at least the three principal entomological entities of the Philippine Government; namely, those of the Bureaus of Science and of Plant Industry, of the Department of Agriculture and Commerce, and that of the College of Agriculture, of the University of the Philippines, would remove whatever cause there may be for any irksome barrier of institutional jealousies or misplaced loyalties that frequently serve to hamper, rather than promote, creative effort.

LEOPOLDO B. UICHANCO
Of the Department of Entomology

I have enjoyed attending several farmers' meetings this winter and hearing those sturdy, hard-headed, commonsense men talk of their problems. I think it takes more of a man, more brains, more character, more courage, more bodily vigor, to be a truly successful farmer than is required in any other calling I know.—DAVID GRAYSON (RAY STANNARD BAKER).

Hearst's International-Cosmopolitan

The clink of every centavo saved is a death-knell for the usurer, the cankerworm of society.—VICTORIA P. DE PAREDES.

The Anti-Usury Bulletin (Manila)

THE GUM DISEASE OF CITRUS OCCURRING IN THE PHILIPPINES[1]

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WITH EIGHT TEXT FIGURES

DISTRIBUTION, IMPORTANCE, AND NATURE OF GUM DISEASE

The gum disease of citrus, (*Citrus nobilis* Lour., *C. aurantium* L., *C. mitis* Blanco, *C. maxima* (Burm.) Merr. and other species) occurring in the Philippines is a destructive disease in old and neglected plantings. Compared, however, with the types of gum diseases caused by *Pythiacystis citrophthora* Smith and Smith and *Phytophthora parasitica* Dastur (*P. terrestria* Sherbakoff) the Philippine forms covered by this paper are but a minor nuisance. The destructiveness of the Philippine forms of gum disease seems to depend upon the attention that the citrus trees have received from the time they were set out in the field.

According to Fawcett and Lee (1926) mal di gomma, or foot rot is a gum disease of citrus which is world wide in distribution. This disease is also known as foot rot and collar rot. Its symptoms and effects are very similar to those caused by *Pythiacystis* gummosis, the most important gum disease of citrus in California. The form of mal di gomma in Florida is considered by Fawcett (1915) and Stevens (1918) to be caused, for the most part, by *Phytophthora parasitica*. In regard to the importance and distribution of mal di gomma in the Orient, Fawcett and Lee (1926, p. 147) state that, "According to Lee, it is probably the most destructive disease which occurs in Japan at the present time and it is also of general occurrence in China and the Philippines." The fungus that causes mal di gomma, however, was not obtained from any of the gum lesions from which isolations were made in this study.

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A portion of the material included in this paper was taken from "Fusarium gummosis of citrus" presented by Inocencio C. Manzo as a thesis for graduation, 1935, with the degree of Bachelor of Agriculture from the College of Agriculture No. 483. The thesis work was prepared in the Department of Plant Pathology. It was started under the direction of Instructor Emiliano F. Roldan and continued under the direction of Associate Professor G. O. Ocfemia.

Lee (1923) reports that the California scaly bark gum disease of citrus is of very general occurrence in the Philippines. California scaly bark or psorosis of citrus has recently been shown by Professor H. S. Fawcett as of a virus nature (1934).

De Leon (1930) of the Citrus Experiment Station of the Philippine Bureau of Plant Industry at Tanauan, Batangas states that the gum disease is causing considerable loss to lemon (*Citrus limonis* Osbeck) and limes (*C. aurantifolia* Swingle). Morada (1930) of the Lamao Experiment Station of the same bureau states that bark rot accompanied by a brownish gummy exudate is the most destructive disease of citrus.

In a survey made by one of the writers (Manzo) in December, 1933 in the principal citrus districts of Batangas Province situated in the towns of Santo Tomas and Tanauan, it was revealed that about 36 per cent of the mandarin citrus trees (*Citrus nobilis*), the commercial species grown in those towns, have gum disease in varying degrees of severity. The disease was especially prevalent and destructive in old orchards.

One of the earlier studies on bark rot and gum disease of citrus in the Philippines was made by Reinking (1921) of the College of Agriculture at Los Baños. He attributed the bark rot and gum disease to a *Diplodia,* resembling most closely *Diplodia natalensis* Pole Evans. Reinking states that gum disease and bark rot are frequently stages of the same trouble. He also states that there are two forms of gum disease of citrus in the Philippines. If the occurrence of the gummy exudate on the trunk and branches of the tree is general the disease is likely to be due to nutritional reasons. If the gummy secretion occurs in more or less definitely localized areas on the trunk, branches and twigs the malady is of a parasitic nature. Lee (1923) and Fawcett and Lee (1926) state that there are great differences between the disease of mandarin orange trees (*Citrus nobilis*) occurring in Japan, China and the Philippines which is called bark rot and the *Diplodia* gumming disease of sweet orange trees (*Citrus sinensis*) in Florida and South Africa. In South Africa, *Diplodia natalensis* usually attacks sweet orange trees (*Citrus sinensis*) but has never been observed on mandarin orange trees *C. nobilis*). Furthermore, infections by *Diplodia* occur close to the ground level and they are not accompanied by white ooze (Lee, 1923).

In addition to chemical injuries and physiological stimuli, various fungi have been associated with gum disease of citrus in different places. Floyd (1913) induced gum production by using thirteen different organic and inorganic chemicals applied beneath the bark, or in holes in the trunks or painted on the surface of the trunks. Fawcett (1923a, b) also reports gummosis induced by chemical stimuli.

Of the parasitic forms, *Diplodia* gum disease, caused by a fungus apparently identical with *Diplodia natalensis* was reported in Florida by Fawcett and Burger in 1911 and by Fawcett in 1913 (Rhoads and De Busk, 1931). The same fungus was reported again by Fawcett in 1915 with citrus gum disease in Florida and Cuba. Although Fawcett is said to have shown that certain other fungi could produce gum disease when introduced into citrus trees, this author found that none of the other fungi could induce citrus to produce gum as copiously as can the *Diplodia* (Rhoads and De Busk, 1931). Stevens (1916, 1917), also in Florida, isolated *Phomopsis citri* and *Diplodia natalensis* from gummosis areas but failed to produce infection typical of gum disease when these fungi were introduced into incisions on healthy bark. For this reason Stevens did not think that any organism could directly initiate gum disease. He believed, however, that *Diplodia natalensis, Phomopsis citri,* and other fungi probably served to make the diseased condition more severe.

Kamat (1927) in India states that isolations from gum lesions of *Citrus aurantium* yielded in most cases a phycomycetous fungus and a species of *Fusarium.* Other organisms such as *Diplodia, Cephalosporium* and bacteria were also obtained from the rotting tissues.

In 1931, Rhoads and De Busk in Florida stated that Fawcett had recently shown at least six destructive parasitic forms of gum disease of citrus in California. These forms include the gum disease caused by *Pythiacystis citrophthora* and mal di gomma caused by *Phytophthora parasitica* which Fawcett and Lee (1926) consider as the most widespread and destructive on citrus. Fawcett (1923) and Fawcett and Lee (1926) state that the other important gum diseases in California are those caused by *Diplodia natalensis. Dothiorella ribis* Grossenbacher and Duggar and *Sclerotinia libertiana* Fuckl. According to Rhoads and De Busk (1931) little is known about the cause of gum disease of citrus in Florida. According to these authors some workers believe that organisms frequently invade gum lesions and aggravate the disease situation, while others are of the opinion that parasites can initiate active gum disease from unprotected mechanical injuries inflicted upon healthy trees.

In Egypt, Ing. Ahmed Sirag-El-Din (1931) reports twig gum disease of citrus caused by *Fusarium solani* (Mart.) Appel and Wollenw.

Nattrass (1934) in Cyprus reports a form of *Fusarium lateritium* Nees from gum and canker of the scion of an orange, *Phytophthora citrophthora* (Sm. and Sm.) Leonian (*Pythiacystis citrophthora*) on diseased tissue of the trunk of a lemon and a fungus probably a species of *Dothiorella* in gum disease of lemon trees. *Hendersonula toruloidea* was isolated from a case of gum disease of the upper branch of a lemon tree.

In Trinidad, British West Indies, Baker (1935) reports that *Phytophthora parasitica* and *P. palmivora* Butler are associated with gum disease of "Marsh" grapefruit and other citrus varieties. Although both species of *Phytophthora* cause gum disease of grape fruit trees and brown rot of the fruit in the field, only *P. parasitica* is chiefly associated with gum disease. In 1927, Ocfemia and Roldan in the Philippines found that *P. palmivora* (*P. faberi* Maubl.) isolated from blighted citrus seedlings and young shoots infected young citrus plants and caused bark rot. At such an early infection, however, gum exudate was not noted in the lesions. Leonian (1925) reports that culture No. 139 of *Phytophthora* from eggplant (Ocfemia and Roldan, 1927, p. 12) from the Philippines is identical with *P. parasitica.* It is not known whether or not the *P. melongenea* K. Sawada reported by Ocfemia in 1925 is identical with culture No. 139 referred to by Leonian in 1925 because the two cultures were isolated at different times. Ocfemia (1925, p. 325) infected the bark of pummelo (*Citrus maxima*) with *Phytophthora melongenae* K. Sawada isolated from eggplant, though at that early stage of the disease no gum was noted.

SYMPTOMS OF GUM DISEASE

The exudation of a gummy substance characteristic of gum disease of citrus studied by the writers appears chiefly on the trunk and larger limbs. In some cases small twigs may also show the gummy exudate. Gummed areas are more abundant at the base of the trunk within one meter above the surface of the ground. The gummy exudate and rotted patches of the bark on the trunk are often very conspicuous.

Early stages of infection

In the early stages of gum disease the first visible indication is the discoloration of the bark. The diseased area is dark, water-soaked, at first occurring in limited areas then gradually rotting in all directions through to the wood (fig. 1). The lesion is accompanied by a flow of gum. At first the gum is watery, somewhat colorless and scanty, soft and sticky to the touch. Later, the flow becomes abundant and brownish in color. It accumulates below the diseased area (fig. 2 and 3) in long circular ridges often reaching the ground. Upon exposure to air the gum becomes hard, transparent and brittle. In the morning or on cool moist days the gum is pliable.

On rainy days much of the gum is washed out. Only the rotted and decayed tissues of the bark indicate that the citrus is diseased. The flow of gum reappears when dry and hot weather comes. In some cases the flow of the gum stops and the progress of the disease is checked. When this occurs the rotting bark dries up and may be readily sloughed off while new tissues are formed around the invaded regions (fig. 4 and 5).

If the lesions are cut out a discolored area on the surface of the wood appears (fig. 6). The discolored area usually extends a little beyond the dead tissues of the bark. A corresponding discolored area may also be noted on the inner surface of the bark. The discolored area or invaded zone varies in color from light brown to brown. It is elongate in shape with the long axis parallel with the axis of the trunk, irregular in outline and varies in size depending upon the age of the lesion. Surround-

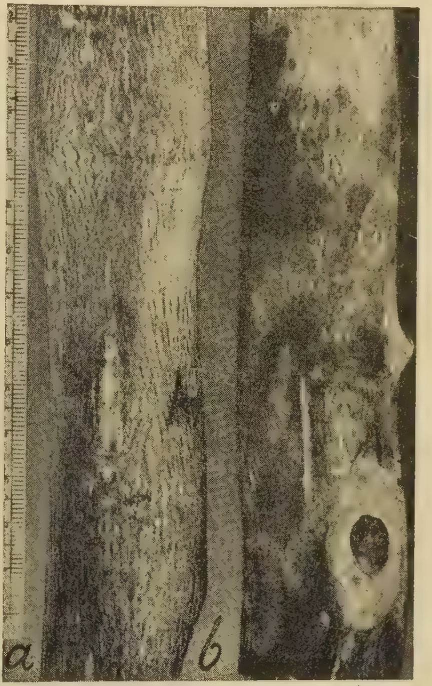

Fig. 1.—(*a*) A portion of the branch of Batangas mandarin, *Citrus nobilis* Lour., showing a young lesion, 4 days old, produced by inoculation with pure culture of *Fusarium solani* (Mart.) Appel and Wollenw. Note the rotted condition of the inoculated portion of the bark. (*b*) The check showing the slit beginning to heal over. Photographed June 8, 1934. × 2/3.

ing the invaded zone there is another area with similar outline but extending farther upward and downward. This area, the outer gummous zone, is somewhat yellowish in color with a clear watery gum. The yellowish color of the outer gummous zone fades toward the margin into the healthy color of the surface of the wood and inner surface of the bark.

Advanced stages of infection

In advanced stages of the disease the dead patches of bark on the trunks and limbs coalesce and form irregular extensive areas showing different stages of rotting. Often they surround completely the trunks and limbs. The bark cracks longitudinally below and above the lesion. The cracking of the bark is accompanied by an abundant flow of gum. Although the flow of the gum may cease,

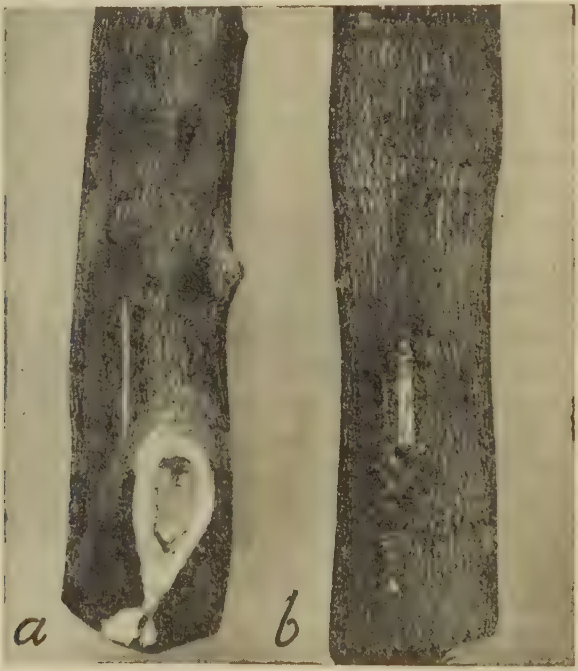

Fig. 2.—(*a*) The check showing the wound beginning to heal over. (*b*) A portion of the branch of Batangas mandarin, *Citrus nobilis* showing a lesion, 10 days old, produced by inoculation with pure culture of *Fusarium solani* (Mart.) Appel and Wollenw. Note the accumulation of gum below the lesion. Photographed June 14, 1934 ×2/3.

the progress of the rotting in all directions continues. The watery sap that flows out of the invaded area contains spores of the fungus. The lesions are transformed into rotting masses and they emit a foul odor. If the rotting of the bark continues the death of the tree follows.

On citrus seedlings the disease is similar to that on mature plants. The seedlings are usually infected at their bases within 15 centimeters from the ground. The lesions are water-soaked at first but later they become soft and rotted. The rotting of the bark is followed by the exudation of gum. Sometimes the lesion is not accompanied with exudation of gum and only rotting occurs. Ing. Ahmed Sirag-El-Din (1931) working on the twig gum disease of citrus caused by *Fusarium solani* (Mart.) Appel and Wollenw. in Egypt found that sometimes infected twigs showed only wilting and afterwards a dying back of these small branches. This author

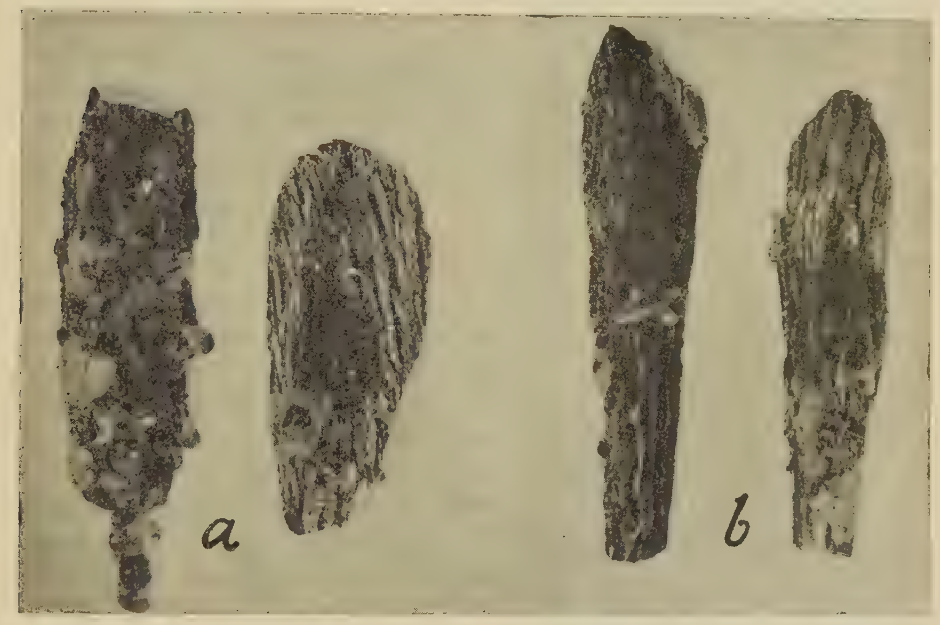

Fig. 3.—(*a*) Portions of the bark of pummelo, *Citrus maxima* (Burm.) Merr. with lesions 16 days old, produced by inoculation with pure culture of *Fusarium solani* (Mart.) Appel and Wollenw. Note the copious gum accumulating below the lesions. (*b*) Portions of the bark of calamunding, *C. mitis* Blanco showing lesions 16 days old, produced by inoculation with pure culture of *Fusarium solani* (Mart.) Appel and Wollenw. Note also the accumulation of gum on the lesions. Photographed September 11, 1934. × 2/3.

noted that the characteristic symptoms are a sudden wilting and shedding of the leaves. Sometimes no exudation of gum could be seen. The rotting progresses in all directions, sometimes girdling the stem. A white felt of mycelium and spores of the causal fungus develop in the form of minute pustules on the surface of the lesion. The invaded area dries and hardens. This form of infection causes the seedlings to wilt. The leaves turn yellow and the plants die. If infection takes place a few centimeters above ground a seedling recovers as soon as it produces sprouts below the point of infection; the upper portion, however, dies.

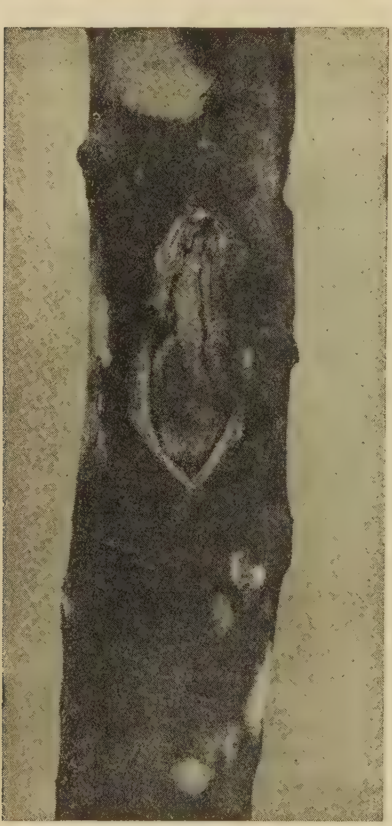

Fig. 4.—A portion of the branch of Batangas mandarin, *Citrus nobilis* showing a lesion healing over under natural conditions. Note the formation of new bark on the margins of the wound. Photographed August 29, 1934. × 2/3.

CAUSE OF GUM DISEASE

Methods of isolation

Fusarium. Isolations were made from the infected bark taken from diseased parts from the base of the trunk to as high as four and one-half meters. In the first method of isolation small sections were cut out with a flamed scalpel from the edge of the invaded zone including a portion of the outer gummous zone. The sections were plated directly on potato-dextrose agar. After three to five days small bits of the hyphae with a small portion of the medium were taken from the edge of the growth and transferred to potato-dextrose agar slants.

In the second method of isolation spore suspension was prepared in a drop of sterile water on a flamed slide. The spores used were taken with a sterile needle from the growth on the diseased parts. Three loopsful of the suspension were taken with a flamed wire loop and introduced into a tube of potato-dextrose agar previously dissolved and cooled to about 40°C. The test tube was rolled between the hands in order to distribute the spores evenly, and the agar was poured into a sterile Petri dish. The Petri dish was rolled gently with slight tipping to one side in order to spread the agar uniformly. The Petri dish was then placed on the table to allow the agar to congeal. The preparation was laid aside in an upside down position and incubated for 48 hours. All uncontaminated colonies were transferred to sterile potato-agar slants.

Isolations to obtain a pure culture of the organism associated with gum disease were made from time to time during the period from August 13, 1933 to August 18, 1934. A total of 113 isolations made from gummed citrus trees of four species; namely, *Citrus aurantium.*, Linn., *C. nobilis, C. maxima,* and *C. mitis* yielded practically pure cultures of *Fusarium.* Fawcett (1923b) and Fawcett and Lee (1926) report that a *Fusarium* species was frequently found closely associated with *Pythiacystis citrophthora* in gum lesions. These authors add that Briosi in Italy in 1878 and McAlpine in Australia in 1899 concluded that mal di gomma in Italy and in Australia is due to *Fusarium limonis* (Briosi) Penz. Fawcett (1923b) and Fawcett and Lee (1926) also state that when *Fusarium* is used alone it cannot produce as extensive a lesion as *Pythiacystis citrophthora* but only a slight killing of a narrow layer of tissue along the slit made for inoculation and with only a slight gum production. In the present study the specimens used for isolating the causal organism were collected principally from Santo Tomas and Tanauan, Batangas

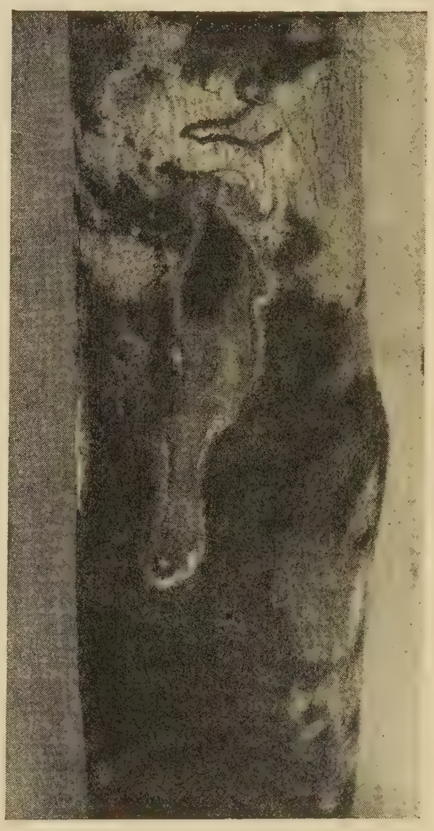

Fig. 5.—A portion of the branch of Batangas mandarin, *C. nobilis* showing a lesion healing over. The tree was inoculated with pure culture of *Fusarium solani* (Mart.) Appel and Wollenw. on August 30, 1933. Rotting and gumming occurred, but after 8 months the disease ceased to develop further. Note the formation of new bark on the margins of the wound. Photographed August 29, 1934. × 1/2.

Province, and Los Baños, Laguna Province. The result of the isolations (made by Manzo) is given in table 1.

TABLE 1

The result of one hundred and thirteen isolations for organisms associated with the gum disease of Citrus

DATE OF ISOLATION	NUMBER OF ISOLATIONS	SPECIES OF CITRUS FROM WHICH ISOLATION WAS MADE	LOCALITY FROM WHICH SPECIMEN WAS OBTAINED	FUNGUS ISOLATED
1933				
August 13	15	*Citrus aurantium* L.	Santo Tomas, Batangas	Fusarium
August 17	10	*Citrus maxima* (Burm.) Merr.	Los Baños, Laguna	Fusarium
September 10	10	*Citrus nobilis* Lour.	Santo Tomas, Batangas	Fusarium
September 11	15	*Citrus nobilis* Lour.	Santo Tomas, Batangas	Fusarium
September 15	20	*Citrus nobilis* Lour.	Santo Tomas, Batangas	Fusarium
1934				
April 18	5	*Citrus nobilis* Lour.	Santo Tomas, Batangas	Fusarium
May 12	10	*Citrus nobilis* Lour.	Santo Tomas, Batangas	Fusarium
May 23	8	*Citrus nobilis* Lour.	Tanauan, Batangas	Fusarium
May 29	6	*Citrus nobilis* Lour.	Santo Tomas, Batangas	Fusarium
June 3	8	*Citrus nobilis* Lour.	Santo Tomas, Batangas	Fusarium
August 28	6	*Citrus mitis* Blanco	Los Baños, Laguna	Fusarium

Diplodia. On September 5, 1933 a few specimens consisting of twigs and branches of *Citrus nobilis* and rough lemon (*C. limonia* Osbeck) were submitted to the Department of Plant Pathology. The specimens were said to have been obtained from different places in Los Baños, Laguna. From the appearance of the specimens it seemed that the disease infected the citrus quite seriously. The surface of the infected parts varied in color from dark brown to almost black. The bark was dry and hard. On the surface of the dark colored areas a thin layer of dust-like accumulation of black soot-like material could be seen. The black masses consisted of the mycelium and pycnospores of a *Diplodia*.

A pure culture of the *Diplodia* was obtained (by Celino) by the spore-suspension method described in method 2 for isolating the *Fusarium.*

Hyphomyces. On September 13, 1933 a dead branch of *Citrus nobilis* which had scattered masses of pinkish to brown fungous growths on the surface of the bark was found at the College of Agriculture at Los Baños. The branch was about three centimeters in diameter and over a meter long. Its leaves were wilted and many of them were already dry. The bark of the branch appeared dead, discolored and with cracks here and there. Scattered on the diseased citrus branch were lumps of glistening pinkish perithecia. The fungus was isolated (by Celino) to pure culture by the spore-dilution method.

Taxonomy

A subculture of the *Fusarium* that was constantly associated with the citrus gum disease and obtained from a total of 113 isolations was sent to noted authorities on this group of fungi, Doctors H. W. Wollenweber and Otto A. Reinking at the Biologische Reichsanstalt in Berlin-Dahlem, Germany. The fungus was identified by these authorities as *Fusarium solani* (Mart.) Appel and Wollenw.

According to this determination the Philippine gum disease of citrus is caused by the same organism that causes the Egyptian gum disease of citrus twigs reported by Ing. Ahmed Sirag-El-Din in 1931.

The *Diplodia* obtained from a few specimens of gum disease and bark rot of citrus at the College of Agriculture is considered to be identical with that reported by Reinking in 1921. In this work this fungus is referred to, at least tentatively, as *Diplodia natalensis* Pole Evans.

The *Hyphomyces* isolated from a single instance of citrus gum disease and bark rot is very closely related to *Hyphomyces haematococcus* (B. and Br.) Wollenw. with which species the fungus is provisionally identified. This species is a weak parasite and in 1933 Ocfemia and Celino reported it as causing the brown bark rot of cacao (*Theobroma cacao* L.) occurring in Los Baños.

Morphology of Fusarium solani (Mart.) Appel and Wollenw.

Mycelium. In pure culture *Fusarium solani* produces both aërial and submerged growth of mycelium. The aërial mycelium is either scanty or dense and from white to lilac and pale orange yellow.[2] The submerged mycelium appears slimy and pale pinkish buff. The mycelium is septate, hyaline with slight bluish-green tint, slightly granular, later becoming vacuolate, branched with slight constriction at the point of branching, thin-walled and more or less smooth in outline. The hyphae are 4.25-7.08 μ wide.

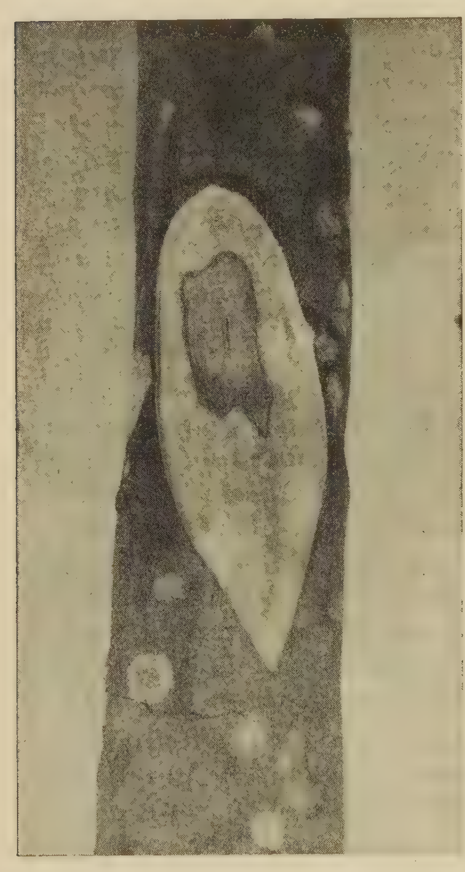

Fig. 6.—A portion of the trunk of Batangas mandarin, *C. nobilis* from which a lesion produced through artificial inoculation with pure culture of *Fusarium solani* (Mart.) Appel and Wollenw. has been cut out. Note the invaded area when infection was 28 days old. Photographed August 29, 1934. × 1/2.

Conidiophores. The conidiophores are formed either from the hyphae or directly from the germinating conidia (fig. 7e). They are either simple or branched and hyaline. The conidiophores lose their contents as soon as the production of the conidia begins.

The conidiophores arise from the hyphae either laterally or terminally. The terminal conidiophores are slender and slightly tapering towards the distal end. The conidiophores which arise laterally from the hyphae are generally short, unicellular and almost club-shaped. They are septate at the point of origin, slightly constricted at the septa, somewhat bulging in the middle and gradually tapering towards the tip.

The conidiophores produced by germinating conidia are formed from any of the cells of the conidia. They are long, erect, usually 3-celled, slightly bulging at the base and gradually tapering towards the tip.

Microconidia. Ing. Ahmed Sirag-El-Din (1931) states that the microconidia of the Egyptian *Fusarium solani* (Mart.) Appel and Wollenw. are 0-2-septate, ellipsoidal, ovoid-fusoid or comma-shaped. The 0-septate are 11.2 × 3.7 μ; the 1-septate, 18.3 × 3.9 μ and the 2-septate, 21.2 × 4.2 μ. The microconidia (fig. 7b) of the Philippine *Fusarium solani* are abundantly produced on some media. They are borne singly at the tips of the conidiophores. They are 0-3-septate ovoid-fusoid to ellipsoidal or reniform, hyaline with slight yellowish-green tint and thin-walled. At first the microconidia are granular but later become vacuolate. They are 8.49-25.84 by 3.54-4.95 μ.

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[2] The color nomenclatures followed in these studies are those of RIDGWAY, ROBERT. 1912. Color standards and color nomenclature. 43 p., 53 colored pl.; 1115 named colors. Washington, D. C.

Macroconidia. Ing. Ahmed Sirag-El-Din (1931) reports that the macroconidia are 0-7-septate, the majority being 1-4-septate. They are more frequently produced than the microconidia. The 1-septate are 26.3 × 4.4 μ, the 2-septate 28.8 × 5 μ, the 3-septate, 32.1 × 5.4 μ, the 4-septate, 34.3 × 5.8 μ and the 5-septate, 36.8 × 6.3 μ. The 0-septate, 6-septate and 7-septate are very rarely produced.

McAlpine (1899) reported that the macroconidia of the *Fusarium* that causes gum disease of citrus in Australia are 22-25 × 2-4 μ; the average is about 30 × 3 μ.

In the Philippine *Fusarium solani* the macroconidia (fig. 7a) are also produced abundantly on almost all media and plant-tissue substrates. They are 1-6-septate, sickle-shaped, hyaline with light yellowish-green tint, and thin-walled. At first they are granular but soon become vacuolate. They are 16.63-54.51 by 3.89-4.60 μ.

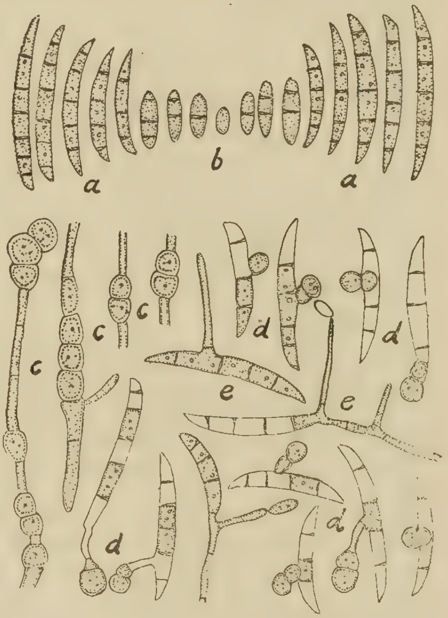

Fig. 7.—Camera lucida drawings by Inocencio C. Manzo of *Fusarium solani* (Mart.) Appel and Wollenw. from gummosis of citrus showing (*a*) macroconidia and (*b*) microconidia from pure cultures on potato-dextrose agar, 46 days old. (*c*) Hyphal and (*d*) conidial chlamydospores from pure cultures on potato-dextrose agar, 91 days old. (*e*) Germinating macroconidia showing germ tubes and conidiophores as seen from hanging drop preparations of sterile water. All figures are about × 376.

Spore germination. The germination of macro- and micro-conidia (fig. 7e) was studied from hanging drop preparations of sterile water in hollow-ground slides. The preparations were kept in a moist chamber at room temperature of about 31°C. in the Laboratory of the Department of Plant Pathology. The germination of the spores at a lower temperature was also studied. The hanging drop preparations were placed in an ice box where the temperature was about 20°C.

Both the macro- and micro-conidia germinated readily in about four hours when the preparation was kept at room temperature, about 31°C. When the hanging-drop preparations were kept in an ice box at a temperature of about 20°C. germination took place in 25 hours. In both cases the conidia became vacuolate after germination and later lost their contents.

The macro- and micro-conidia both germinate by the production of fine hyaline germ tubes which arise from one or both ends of the spores. In some cases germ tubes arise from the middle cells of the conidia.

In 24 hours the germ tubes became septate, slightly granular and branched with slight constriction at the point of branching. At this time conidiophores were beginning to appear.

Chlamydospores. Terminal and intercalary chlamydospores are produced from hyphae and conidia of cultures about 80 days old. They are borne either singly or in a chain of two to five (fig. 7c). They are globose, thick-walled, hyaline with light bluish-green tint, granular and 7.08-12.90 μ in diameter. Ing. Ahmed Sirag-El-Din (1931) in Egypt, states that the mycelial chlamydospores are 8.7 × 7.3 μ. They are also borne singly or in chains but never in clusters. They are either terminal or intercalary. In some cases chlamydospores are produced by the conidia on short pedicels (fig. 7d). The conidial chlamydospores are 5.31-8.85 μ in diameter.

Morphology of Diplodia natalensis Pole Evans

Pycnidia. In culture of *Diplodia natalensis* the pycnidia are produced profusely. They are gray to dark-colored, more or less spherical or rounded on one side and slightly flattened on the other. The pycnidia are produced singly or in clusters. Individually, the pycnidia (fig. 8a) measure from 500 to 2500 μ in diameter (external dimensions). Clusters of pycnidia measure from 4000 to 6000 μ in width.

Pycnospores. The pycnospores, (fig. 8b) are small and elongate with rounded ends; hyaline and non-septate when young, dark colored, striated and with one septum when old (fig. 8). They measure from 18.9-29.4 × 10.5-16.8 μ with an average of 22.6 × 12.3 μ. Germinating pycnospores are shown in figure 8c.

Cultural studies of Fusarium solani (Mart.) Appel and Wollenw.

The character and color of growth of *Fusarium solani* (Mart.) Appel and Wollenw. were studied in 5-day-old cultures on prune agar, corn-meal agar, citrus-bark decoction agar, steamed corn meal, dextrose agar, nutrient agar, potato agar, oatmeal agar, potato-dextrose agar, water agar and plant-tissue substrates. Either three drops of 25 per cent lactic acid or dextrose at the rate of 10 per cent of the media were added to some of the agars. The results of this study are given in table 2.

TABLE 2

Comparative amounts of growth and color produced by Fusarium solani (Mart.) Appel and Wollenw. from Citrus gum disease on slant media and plant-tissue substrates to some of which dextrose and 3 drops 25 per cent lactic acid had been added (observed when the cultures were five days old)

MEDIA	COLOR OF GROWTH	CHARACTER OF GROWTH
3 per cent glycerine agar	white	scanty
4 per cent glycerine agar	white	submerged and scanty
5 per cent glycerine agar	white	scanty
water agar	white	scanty and submerged
dextrose agar	white	scanty
potato agar	pinkish buff	abundant and fluffy
potato agar + lactic acid	pallid neutral gray	abundant
potato-dextrose agar	white to tilleul buff	dense
steamed corn meal	purplish lilac	abundant and fluffy
corn meal agar	white	thin
corn meal agar + lactic acid	white	scanty
oatmeal agar	pallid purplish gray	abundant and fluffy
oatmeal agar + lactic acid	white to pale cinnamon-pink	abundant and fluffy
prune agar	white	scanty and fluffy
prune agar + lactic acid	pale gull gray	scanty and fine
prune agar + dextrose	pearly gray	scanty and submerged
nutrient agar	white to pale olive-buff	medium dense and fine
nutrient agar + lactic acid	white to pale olive-buff	abundant and dense
nutrient agar + dextrose	white to pale orange-yellow	abundant and dense
citrus bark-decoction agar	white to pale pinkish buff	scanty and fine
citrus bark-decoction agar + lactic acid	white to pearl gray	medium dense and fine
citrus bark-decoction agar + dextrose	white to pale olive-buff	medium dense and cottony
sweet potato plugs	white to pale olive-buff	medium dense and cottony
potato plugs	pale vinaceous	dense and cottony
papaya plugs	tilleul buff	medium dense
cassava root plugs	white to light buff	dense and cottony
steamed bean pods	pale cinnamon-pink	dense and cottony

Proofs of pathogenicity

In Egypt, Ing. Ahmed Sirag-El-Din (1931) obtained infection of citrus through injuries with *Fusarium solani* (Mart.) Appel and Wollenw.

Inoculation experiments with the Philippine Fusarium solani (Mart.) Appel and Wollenw. Healthy citrus trees were selected in the field. The trees were labelled for use in inoculation experiments with *Fusarium solani.* Four methods of inoculation were followed. In the first method the surface of the bark to be inoculated was first washed with 1:1000 mercuric bichloride solution. The disinfectant was thoroughly washed off with sterile water. Vertical slits about two centimeters long and reaching the wood were made with a flamed scalpel on the disinfected bark. The fungous growth including a small portion of the medium was inserted into the slits with a flamed scalpel. The inoculated portions were either covered with cellophane paper or left uncovered. In most of the inoculations no cover was placed over the inoculated parts of the trees. With this method of inoculation diseased tissues, gum, and pure cultures of *Fusarium solani* were used as inoculum.

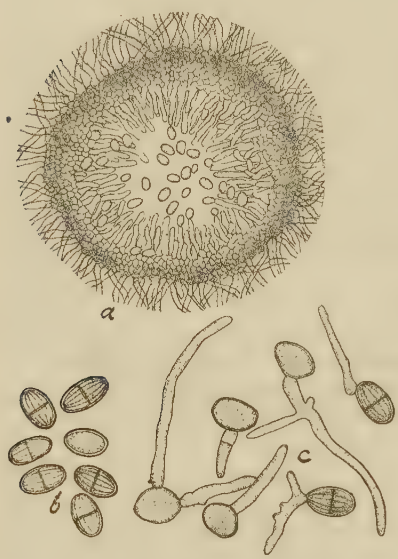

Fig. 8.—Drawings by Martin S. Celino of the *Diplodia* considered identical with *Diplodia natalensis* Pole Evans, associated with citrus bark rot and gum disease. (*a*) Cross section of a young pycnidium, showing the young conidiophores and the conidia. A semi-diagrammatic drawing made under the low power objective of the microscope. Nearly × 78. (*b*) Mature conidia showing cross walls and striations. The spore without cross wall and striation is a young pycnospore. × 250. (*c*) Some germinating conidia. × 250. Drawings from (*b*) to (*c*) were made with the aid of a camera lucida.

The second method of inoculation consisted of first scraping the surface of the disinfected bark with a sterile scalpel and then applying pure culture of the causal organism on the exposed inner tissues of the bark.

In the third method of inoculation the bark was not injured. The culture of *Fusarium solani* with a portion the agar medium was applied directly on the surface of the disinfected bark.

The fourth method of inoculation consisted of spraying the bark with a suspension, in sterile water, of the spores of *Fusarium solani.* Inoculation of potted citrus seedlings placed outside of the Plant Pathology Laboratory was made. On the seedlings the site of inoculation on the stem was washed with 1:1000 mercuric bichloride solution and the disinfectant rinsed off thoroughly with sterile water. Using a flamed scalpel, vertical slits about one and one-half centimeters long were made on the bark of the seedlings within fifteen centimeters from the base. Pure cultures of the fungus were inserted into the slits. Moist cotton was wrapped around the inoculated portions and the whole covered with cellophane paper. The inoculated seedlings were kept in the laboratory for two days. The control plants were similarly treated except that sterile potato-dextrose agar was used as inoculum.

All inoculation experiments were checked with controls in which the plants were treated in the same manner as those to be inoculated, except that no fungus was applied.

The results obtained from inoculations of citrus trees with *Fusarium solani* under controlled conditions in the field and citrus seedlings in the experimental plot of the Department of Plant Pathology at Los Baños may be summarized as follows:

1. In inoculations with diseased tissues, exuded gums, and pure cultures of *Fusarium solani,* citrus trees and seedlings were infected while the checks remained healthy. *Fusarium solani* was isolated from the diseased parts produced.
2. When fragments of diseased tissues were used as inoculum infection was slow. Gumming was observed one month after inoculation.
3. Inoculations with freshly exuded gum produced infection within five days and gumming took place from eight to ten days after inoculation. The progress of the disease, however, was slow.
4. Inoculations with pure cultures of *Fusarium solani* produced infection in from two to ten days. Gumming was observed from three to fifteen days after inoculation, and rotting of the bark was extensive.
5. Inoculations with pure cultures of the fungus through incisions produced from 95 to 100 per cent of infection in from two to ten days after inoculation. The gummy secretion oozed out after three to fifteen days.
6. Inoculations by placing the fungus from pure cultures on scraped surface of the bark produced only 60 to 66 per cent of in-

fection. Although gumming occurred in from seven to fifteen days after inoculation, no rotting of the bark followed.

7. *Fusarium solani* did not infect the sound uninjured bark. Mechanical injuries inflicted on the trunks, branches, and twigs of *Citrus* did not produce gumming unless *Fusarium solani* was applied.

8. In most cases of infection with pure cultures of *Fusarium solani*, softening and rotting of the invaded tissues were the initial symptoms produced. These symptoms were accompanied with gum exudation which was at first watery and thin but later became abundant. In advanced stages of infection in inoculation experiments a considerable amount of gum oozed out from the lesions and longitudinal cracks of the bark. A fetid odor was sometimes emitted.

9. Inoculations of citrus seedlings with pure cultures of *Fusarium solani* produced 100 per cent of infection in from two to three days after inoculation. There was only slight gumming but the rotting of the bark was extensive. Some of the infected seedlings wilted and died, although most of them recovered from the disease as soon as sprouts appeared below the lesions.

10. *Fusarium solani* was reisolated from the lesions produced in artificial inoculations with pure cultures.

Diplodia natalensis Pole Evans. On September 25, 1933 two citrus plants (*C. nobilis*) were inoculated (by Celino) in the field with pure culture of the fungus *Diplodia*. Wounds were inflicted on the bark by means of a sterile scalpel and the fungus was inserted into them. On December 14, 1933 the inoculated regions of the citrus branch were rotted with small longitudinal cracks and gum here and there. On January 13, 1934 the infection had spread to three centimeters in diameter and nine to twelve centimeters in length. Portions of the woody part of the plant were exposed.

Hyphomyces haematococcus (*B* and *Br.*) *Wollenw.* On September 21, 1933 two branches of citrus in the field were inoculated (by Celino) with a pure culture of *Hyphomyces haematococcus* by applying the inoculum through wounds. On October 13, 1933 small areas in the bark were dead or rotted in several places and pinkish perithecia of the fungus were found on the surface. The *Fusarium* stage of the fungus was found with the diseased tissues of the inoculated branches.

The progress of the disease in the inoculated branches of citrus was slow. About the end of January, 1934 the diseased areas on the branches were only from two to two and a half centimeters wide and from three to four centimeters long. When the dry season came in March, 1934 the lesions ceased to grow. Corky materials formed around the regions of infection and prevented the parasite from causing further injury.

LIFE HISTORY OF FUSARIUM SOLANI (MART.) APPEL AND WOLLENW. IN RELATION TO THE PRODUCTION OF GUM DISEASE OF CITRUS

Seasonal appearance of the disease

The gum disease of citrus is prevalent throughout the year although its severity varies at different seasons. In general, the effects of the disease are more conspicuous in the dry season than in the rainy.

Observations in the field showed that infection becomes severe from the latter part of January to the early part of May. During April, gum disease is most prevalent. The lesions produced are extensively rotted and a considerable amount of gum oozes out from them. The disease begins to be less conspicuous from the latter part of May to the early part of January. In July and August the trees seem to recover from the severe infection of the disease in April and May. The lesions produced at this time are localized and they develop slowly.

In the rainy season not much gum is noted oozing out from the lesions. Only a slight rotting and flow of sap occur. The disease seems to be arrested in its development. When the hot season comes these lesions enlarge and extensive rotting and gumming occur. The lesions progress rapidly and no partial healing takes place until the beginning of the rainy season.

Spore production

In pure culture, *Fusarium solani* produced micro- and macroconidia as well as chlamydospores. Macro- and micro-conidia are produced in both old and young cultures while chlamydospores are present only in old cultures.

On the host, *Fusarium solani* produces both micro- and macroconidia. They are embedded in pustule-like bodies which appear as minute eruptions on the surface of the lesion. In both natural infection and artificial inoculation work in the field *Fusarium solani* produced spores on the host.

Sources of inoculum

On cool moist days spores of *Fusarium solani* were present on the surface of the lesions of *Citrus*. In was also found that the sap coming out of the lesions contains spores of *Fusarium solani*. The gum that exudes from infection with *Fusarium solani* contains spores. From this finding it seems evident that the inoculum for subsequent infection may arise from the diseased bark and sap and gum coming out of the lesions.

Method of dissemination

Spore catching experiments were conducted to determine whether or not the spores of *Fusarium solani* are also disseminated by wind. On September 20, 1934, 11 clean and sterile glass slides which were smeared with a thin film of petrolatum were examined after 24 hours and numerous micro- and macro-conidia were found on all of them. Drops of water were found on the glass slides and in these drops some of the conidia germinated. The experiment was repeated on September 22, 1934 using 20 glass slides. In the second experiment micro- and macro-conidia were found on 16 glass slides after 12 hours of exposure. These two experiments seem to show that the spores of *Fusarium solani* may be readily spread by wind.

The gummy exudates and sap that come out of the lesions contain spores of the causal fungus. It seems that in the orchards the disease may be spread through the transfer of these infective materials from one tree to another. The accumulation of gum and sap on the truck may aid in the gradual increase in the number of lesions on the tree.

Furthermore, the gummy exudate is soluble in water and when it rains spatterings of the dissolved gum may spread *Fusarium solani* to other parts of the same tree or other trees close by. McAlpine (1899) stated that the gummy exudates dissolved in the irrigation water is an important factor in the spread of collar rot, or mal di gomma in citrus orchards in Australia.

Method of infection

McAlpine (1899) working on mal di gomma in Australia reported that *Fusarium limonis* caused infection of weakened tissues. Similarly, Fawcett (1923b, 1925) found that in the case of *Sclerotinia* gummosis and *Botrytis* gummosis mechanical injuries or defects in the bark are needed before the fungus can penetrate the tissues of the host. In inoculation experiments conducted by the writers it was noted that *Fusarium solani* from pure cultures, fragments of diseased tissues and gummy exudate caused infection through slits of the bark. Pure cultures caused infection when placed on scraped off parts of the bark but not through the uninjured portions of trunks, branches and twigs.

Method of tiding over adverse conditions

Observations in the field showed that *Fusarium solani* of the citrus gum disease is present in the bark of infected trees throughout the year. The mycelium of the fungus is present in the marginal fringe of the invaded zone of the lesions. It remains inactive when partial healing of the lesions occurs. When favorable conditions come, rapid development takes place and the infection is renewed.

Microscopic examinations showed that spores of the fungus were present in gummed dead bark. According to McAlpine (1899) the gum may act as a preservative for the conidia of the gum disease fungus of citrus and prolong their vital activity.

In the Philippines it seems that usually the mycelium in the bark carries the fungus over between seasons. To a limited extent it seems possible in the Philippines for the conidia of the fungus to remain alive on the rotting bark and gum.

CONTROL MEASURES

To a certain extent the gum disease of *Citrus*, like many other diseases, may be prevented by protecting wounds of citrus trees from infection. In the Tanauan Citrus Experiment Station of the Bureau of Plant Industry in Batangas Province and in some orchards in Santo Tomas, in the same province, the trees are painted from the base of the trunk to about two meters high with lime-sulfur paste. Reinking (1921) recommends protecting the trees from the disease by spraying them with Bordeaux mixture prepared according to the formula: 1.8 kgm. copper sulfate, 1.8 kgm. stone lime and 190 liters water. According to Stevens (1918) painting the trunk up two to three feet from the ground with lime-sulfur paste prepared by taking equal parts of air-slaked lime and powdered sulfur mixed with sufficient water to make a thin paste, protects the trees from infection. Fawcett (1923) recommends painting the trunks of *Citrus* with Bordeaux paste (4-4-6 formula) to protect them from gummosis.

Removal of diseased tissues and treatment of wounds

When a citrus tree is infected with gum disease all infected tissues should be removed by cutting out the diseased bark including a part of the healthy wood and covering the wound with a fungicide.

An oil paint should be used after disinfection of the wounds. In cases where a branch is badly infected it should be pruned off and the wound disinfected and painted.

Various materials have been used in the treatment of wounds after cutting out gummosis lesions. Smith and Butler (1908) in California recommend the painting of wounds with grafting wax prepared by using four pounds (1.81 kgm.) of resin, one pound (.45 kgm.) of beeswax and one pound of raw linseed oil. Grossenbacher (1916) in Florida also recommends the treatment of wounds with grafting wax. Smith and Butler (1908) further recommend the application of "neat's-foot oil" or a one-tenth solution of caustic potash in water for thoroughly painting the whole trunk.

Stevens (1918) in Florida, used avenarius carbolineum, pine tar or white lead paint to cover the wounds. Stevenson (1918) in Porto Rico, Reinking (1921) in the Philippines and Fawcett (1923b) and Fawcett and Lee (1926) recommend the application of Bordeaux paste on wounds made by cutting out the diseased bark. When the edges of the wound begin to heal, which is usually about 10 days after the application of Bordeaux paste, the wound is painted with asphalt paint (Fawcett and Lee, 1926) or gas tar (Stevenson, 1918).

Kamat (1927) in India, recommends the application on the wound of either crude carbolic acid (one part carbolic acid and one part water) or Bordeaux paste prepared by taking one pound (.45 kgm.) of copper sulfate, two pounds (.90 kgm.) of unslaked lime and 16 pounds (7.25 kgm.) of water.

In the treatment for bark rot of citrus De Leon (1930) recommends removal of strips of bark one millimeter wide and one centimeter apart over and slightly beyond the diseased area. This entire area should be painted thoroughly with carbolineum so that all of the grooves are filled with the paint. All the areas debarked because of the disease should be thoroughly cleaned and then painted with asphaltum-linseed oil paint. Morada (1930) states that making parallel and crosswise cuts on the bark, three millimeters wide and reaching through to the wood, and then painting the wounds with carbolineum is an effective treatment for bark rot.

For covering wounds after cutting out gummosis lesions, Aldaba (1929) recommends the use of asphaltum paint. This paint, however, does not stick on a wet surface, so the wounds should be dried before applying.

Observations (by Manzo) in some citrus orchards in Santo Tomas, Batangas showed that in many cases the application of carbolineum stopped gumming temporarily, and the lesions appeared dry for a few days or weeks, but later, gumming or sap flow resumed.

Experiment 1. On May 2, 1934 both naturally infected and inoculated citrus trees were selected in the orchards. With a disinfected pruning knife the affected parts of the bark were cut out one to two centimeters beyond the invaded zone of the lesions. The cuts were made perpendicular to the surface of the wood. The parts peeled off were oval in shape, with the long axis parallel with the long axis of the trees. The surface of the exposed wood was scraped off carefully. The wounds were disinfected with either four per cent formalin solution or a solution of mercuric bichloride (1:1000). The disinfected wounds were allowed to dry for about a day and then painted with either the common green oil paint (Sapolin brand), Bordeaux paste (4-4-6 formula), or coal tar. A brush was used for applying the covering material on the wonds. For checks the cuts were similarly treated but they were not disinfected and painted. Tests were also made in which the wounds were painted without disinfection.

Experiment 2. This experiment was performed on May 9, 1934 and it was a repetition of experiment 1 in all details.

The results of the two experiments showed that gummosis may be effectively controlled by properly cutting out the diseased parts. The essential thing seems to be the complete removal of the fungus from the border line of the lesions. In the few treatments tested, the formation of new bark was rapid when coal tar was used for covering the wounds. Lead paint also served as a good covering material but it was inferior to coal tar in its effects. Wounds on which Bordeaux paste (4-4-6 formula) was applied healed slowly. This paste seemed to have a detrimental effect on the exposed tissues of the bark and thus retarded healing. Besides the deleterious effects that Bordeaux paste may have on the exposed tissues of the bark it is harder to apply because it does not stick well on a moist surface and it is easily washed off by rain.

Regarding the disinfectants used, mercuric bichloride solution (1:1000) was better than four per cent formalin solution. Formalin seemed to harm the tissues of the bark and thereby delayed healing of the wounds. The wound healed slower when formalin was used as disinfectant than when it was not disinfected. The best result was obtained by using coal tar for covering the wound either with or without mercuric bichloride for disinfection. Coal tar is more desirable to use than other paints and fungicides because it sticks well even on moist surfaces.

Proper care of citrus plantings

In the field, the gum disease caused by *Fusarium solani* was more severe in neglected plantings. Trees in open cultivated fields were severely attacked by gum disease while those with shade at the base were less severely infected. It seems possible to reduce infection by providing shade for the trunks of trees. As much as possible injuries on the bark should be avoided in the cultivation of the trees because these become avenues of entrance for *Fusarium solani*. Aldaba (1929) recommends the production of healthy vigorous trees by keeping the orchard well drained and fencing it to prevent animals from making abrasions on the trees. In the control of *Pythiacystis* gummosis Fawcett (1923) recommends pulling "back the soil from the base of the trunk thus exposing the top of the main roots and making a circular ridge to exclude irrigation water from standing in contact with the trunk."

Use of resistant stocks

Many authors suggest the use of resistant stocks to control diseases of citrus. Reinking (1921) in his discussion of bark rot and gum disease caused by *Diplodia natalensis* found the disease on practically all species of *Citrus*. According to this author "it does not seem as if a highly resistant variety can be selected."

Fawcett and Lee (1926) in their discussion of *Pythiacystis* gummosis, state that the common lemon (*Citrus limonia*) has the lowest resistance to the disease and the sour orange (*Citrus aurantium*) the highest. The sour orange is said to be resistant to all infectious gum diseases of importance. McAlpine (1899) states that in the case of collar rot, or mal di gomma caused by *Fusarium limonis* (Briosi) Penz. the sweet seedling orange tree (*Citrus aurantium*) appears to be the most susceptible and that the mandarin orange (*Citrus nobilis*) is only occasionally affected. The Seville, or bitter orange (*Citrus bigaradia*) is the least susceptible, being almost entirely free from the disease (McAlpine, 1899).

In the present study, Batangas mandarin (*Citrus nobilis*) was observed to be the variety most susceptible to gum disease caused by *Fusarium solani* in the field. Extensive rotting accompanied by gum and sap flow is very common in this species. Gum disease oftentimes kills trees. The sweet orange (*Citrus sinensis*) is also very susceptible to the disease. The pummelo (*Citrus maxima*) is next to sweet orange in degree of susceptibility. The manifestation of the disease in pummelo, however, is similar to that in sweet orange. Of the four commercial species of citrus, *Citrus mitis* Blanco (calamunding or calamansi) is the least susceptible to gum disease caused by *Fusarium solani*. Although the calamunding is subject to gum disease, gumming is sporadic and limited in extent with very slight rotting of the bark. To determine the relative susceptibilities of the four commercial species of *Citrus* (*C. nobilis, C. mitis, C. sinensis* and *C. maxima*) the writers carried on inoculations in the field.

The inoculation tests with *Fusarium solani* showed that all of the four commercial species of *Citrus* in Santo Tomas and Tanauan, Batangas and in Los Baños, Laguna are susceptible to gum disease but in varying degrees. In general, the lesions progressed more rapidly in Batangas mandarin (*C. nobilis*) and sweet orange (*C. sinensis*) than in pummelo (*C. maxima*) and calamunding (*C. mitis*). Gum exudate was common in all of the species, but in varying amounts. In the case of Batangas mandarin and sweet orange, the exudation of gum was slight but there was extensive rotting and abundant sap flow. The lesions on pummelo (fig. 3a) and calamunding (fig. 3b) were characterized by copious exudation of gum but with only slight rotting of the bark. When the lesions were cut out it was noted that the invaded zone was extensively rotted in Batangas mandarin while there was a slight callus formation around the lesions in pummelo, sweet orange, and calamunding. The progress of the disease was most rapid in Batangas mandarin and slowest in calamunding.

SUMMARY

1. The gum disease attacks the important species of *Citrus* and the trouble is prevalent in old and neglected plantings. The Philippine types of gum disease are not as destructive as those caused by *Pythiacystis citrophthora* Smith and Smith and *Phytophthora parasitica* Dastur that occur in California. Gum disease is reported on citrus in Italy, Australia, California and Florida in the United States, Egypt, China, Japan, South Africa, India, Cyprus, Porto Rico, Cuba, Trinidad in the British West Indies, and perhaps in other countries where citrus is grown.

2. Gum disease infects chiefly the trunk and the larger limbs of citrus trees but it may also attack the twigs and even the fruits. Infection is usually severe at the base of the trunk within one meter

above the surface of the ground. It is called gum disease because infected citrus trees show a gummy exudate on the infected parts. The presence of gummy exudate and the rotted patches are the most conspicuous symptoms of the disease. The rotting bark often emits a fetid odor. The cracking of the bark below and above the lesions is accompanied by a copious exudation of gum. The lesions may encircle the trunk and eventually kill the tree. The disease also attacks the base of citrus seedlings and sometimes kills them. However, citrus seedlings are less susceptible to gum disease than mature plants.

3. In the present study, *Fusarium solani* (Mart.) Appel and Wollenw., the organism to which the gum disease of *Citrus* in Egypt is attributed, was present in practically all of the specimens studied. A few specimens contained a *Diplodia* which is tentatively referred to as *Diplodia natalensis* Pole Evans. In a single instance a *Hyphomyces* provisionally identified with *Hyphomyces haematococcus* (B. and Br.) Wollenw. was isolated. *Fusarium solani* was isolated from the margins of the invaded zone. This fungus produced the disease by inoculation using fragments of diseased bark, exuded gum and pure cultures. Infection took place only through wounds. Mechanical injuries on citrus trunks and branches to which no fungus was applied did not induce gumming. Both the *Diplodia* and the *Hyphomyces* were capable of producing a type of gum disease when used in inoculation experiments.

4. In pure culture, *Fusarium solani* produced both aërial and submerged mycelium and 0-3-septate micro- and 1-6-septate macroconidia. The microconidia are 8.49-25.84 by 3.54-4.95 μ. The macroconidia are 16.63-54.51 by 3.89-4.60 μ.

5. On various culture media to some of which 10 per cent dextrose or 3 drops of 25 per cent lactic acid had been added and on plant-tissue substrates the aërial mycelium varied from scanty to dense and white to pinkish buff and purplish lilac. The color of the substrate ranged from colorless to violet carmine and olive buff. Spores were produced on all media and plant-tissue substrates. Potato dextrose agar and oatmeal agar were the most suitable media for *Fusarium solani* in the present study.

6. In their relation to gum disease the four commercial species of *Citrus* in the Philippines may be arranged in the descending order of the degree of susceptibility as follows: *Citrus nobilis* Lour., *C. sinensis* Osbeck, *C. maxima* (Burm.) Merr., and *C. mitis* Blanco.

7. Gum disease of citrus is prevalent throughout the year. The effects of the disease are more conspicuous during the dry season than during the rainy months.

8. The inoculum for infection in the field may come from the rotted bark, and sap and gum oozing out of the lesions.

9. *Fusarium solani* seems to tide over adverse conditions in the form of spores in the gummed rotted bark and in the form of mycelium in the partially healing lesions.

10. All wounds and injuries produced on the trees should be disinfected and protected from infection. Well cared for trees are said to be less infected than neglected plantings. The use of resistant stocks of citrus recommended by various authors merits further study as a practical measure for controlling gum disease in the Philippines. In the present work, limited trials showed that gum disease of citrus may be controlled by cutting out all the invaded bark to the healthy wood. After removing the diseased parts the wounds should be disinfected with mercuric bichloride solution (1:1000) and then painted with coal tar.

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ALCOHOL AND ALCOHOL-GASOLINE BLENDS AS FUELS FOR AUTOMOTIVE ENGINES: V. STUDIES ON THE PERFORMANCE OF AN EIGHT-CYLINDER ENGINE USING GASOLINE, DEHYDRATED ALCOHOL, AND DEHYDRATED ALCOHOL-GASOLINE MIXTURES[1]

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WITH ONE TEXT FIGURE AND SEVEN CHARTS

It was the purpose of this study to compare the performance characteristics of gasoline, of dehydrated alcohol, and of dehydrated alcohol-gasoline mixtures when used as fuels in an eight-cylinder engine. The important points considered were ease of starting, fuel consumption, maximum power developed, and general behavior of the engine at full and at fractional loads when tested on the block.

MATERIALS

The engine tested was a Ford V-8 1934. Instead of the regular Ford radiator, a 50-gallon drum arranged as shown in figure 1 served as the tank for cooling the jacket water. The jacket water temperature was controlled by means of a hose connected to a water main. The drum was provided with two discharge faucets. The fan blades were removed.

The fuels used were as follows:

(1) Gasoline — ordinary motor gasoline available in gas stations. Specific gravity at 15°C. = 0.745.

(2) B-dehydrated alcohol — alcohol strength of about 98.5 per cent by volume denatured with about 5 per cent sulfuric ether. Specific gravity at 15°C. = 0.797.

(3) Mixture A — 90 per cent gasoline + 10 per cent B-dehydrated alcohol. Specific gravity at 15°C. = 0.754.

(4) Mixture B — 80 per cent gasoline + 20 per cent B-dehydrated alcohol. Specific gravity at 15°C. = 0.756.

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[1] Experiment Station contribution No. 1107. Received for publication October 30, 1935.

The author reported in the PHILIPPINE AGRICULTURIST, vol. 24, No. 9, February, 1936 some results of his experiments on alcohol and alcohol-gasoline mixtures as fuels for an eight-cylinder engine. In these experiments the strength of alcohol used was not as high as the dehydrated alcohol used in the tests discussed in this paper.

(5) Mixture C — 70 per cent gasoline + 30 per cent B-dehydrated alcohol. Specific gravity at 15°C. = 0.761.
(6) Mixture D — 60 per cent gasoline + 40 per cent B-dehydrated alcohol. Specific gravity at 15°C. = 0.771.
(7) Mixture E — 50 per cent gasoline + 50 per cent B-dehydrated alcohol. Specific gravity at 15°C = 0.772.
(8) Mixture F — 40 per cent gasoline + 60 per cent B-dehydrated alcohol. Specific gravity at 15°C. = 0.781.
(9) Mixture G — 30 per cent gasoline + 70 per cent B-dehydrated alcohol. Specific gravity at 15°C. = 0.782.
(10) Mixture H — 20 per cent gasoline + 80 per cent B-dehydrated alcohol. Specific gravity at 15°C. = 0.788.
(11) Mixture I — 10 per cent gasoline + 90 per cent B-dehydrated alcohol. Specific gravity at 15°C. = 0.794.

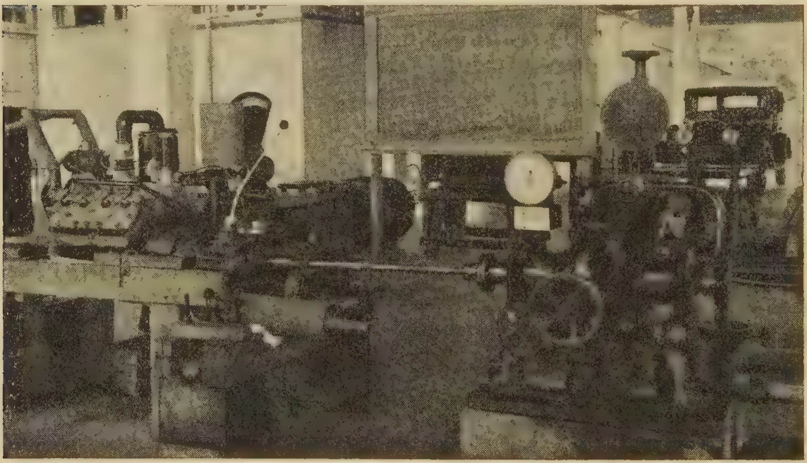

Fig. 1.—Layout of the engine and of the dynamometer during the test.

A Froude absorption hydraulic dynamometer of the type D. P. × 4 was used for brake loads. The engine speeds were measured by a very accurate tachoscope.

EXPERIMENTAL

The brake tests includes the determination at speeds 2200, 1800, 1400, 1000, and 600 r.p.m. of the following:

(1) Maximum brake horsepower.
(2) Maximum fuel economy at maximum, at three-fourths, at one-half, and at one-fourth maximum brake horsepower.

The maximum load was determined during the maximum horsepower run at specified speed. For runs at fractional loads at the same speed, the torque at three-fourths, at one-half, and at one-fourth the maximum for this speed was set by fixed throttling. The carburetor jets that were found to give optimum fuel economy at maximum horsepower tests were used in all fractional load tests for each fuel. The maximum load was made nearly the same for all fuels.

The engine was first run-in for at least 30 minutes before any test was started. Numerous trial runs were made to find the setting of the carburetion and of the ignition systems that would give the optimum fuel consumption for the maximum load at highest running speed on full throttle. The engine was run at a condition of sustained operation under the stipulation of the test. Data were obtained only when the load, fuel consumption, cooling water temperature, and engine r.p.m. were reasonably constant, steady, and could be maintained throughout the run. Regular tests were made to include the highest and the lowest steady operating speeds that were favorable to all fuels. The duration of the test was at least 15 minutes for each run. The outlet water temperature of the engine was kept so far as possible between 170°F. and 180°F.

The specific gravity of each fuel was determined at 15°C.

All the tests were conducted in the engine testing laboratory of the Department of Agricultural Engineering, College of Agriculture, University of the Philippines, between the dates March 16, 1935 and June 10, 1935.

RESULTS AND DISCUSSION

A 50-gallon tank was used for cooling the jacket water because the engine over-heated at high speeds on full throttle with the use of the ordinary Ford radiator. By regulating the amount of the incoming and of the outgoing water in the 50-gallon drum, the jacket water temperature was maintained at about 180°F.

Ease of starting. Starting from cold with gasoline and with the mixtures containing as high as 40 per cent dehydrated alcohol was easy. With the mixtures containing more than 40 per cent alcohol, the time in which the choke was kept partially closed before the engine started and continued to run was a few seconds longer than the required time for starting the engine with gasoline.

Fuel consumption and maximum power developed. The size of the jets used when the engine was run on gasoline was considered very economical. The use of smaller sizes resulted in the engine developing less power and operating unsteadily especially at full throttle. Larger jets caused unevenness in operation and gave high fuel consumption. In the case of the mixtures, the use of jets a little larger than those employed in the regular tests for each fuel made the engine develop greater overload but at the expense of very high fuel consumption. It was noted that with mixtures containing at least 60 per cent dehydrated alcohol the engine developed at 2200 r.p.m. maximum power that was about 12 per cent higher than the maximum that could be developed with gasoline at the same speed. This action was accomplished with the engine showing no sign of unevenness in operation or exhibiting over-rich mixture.

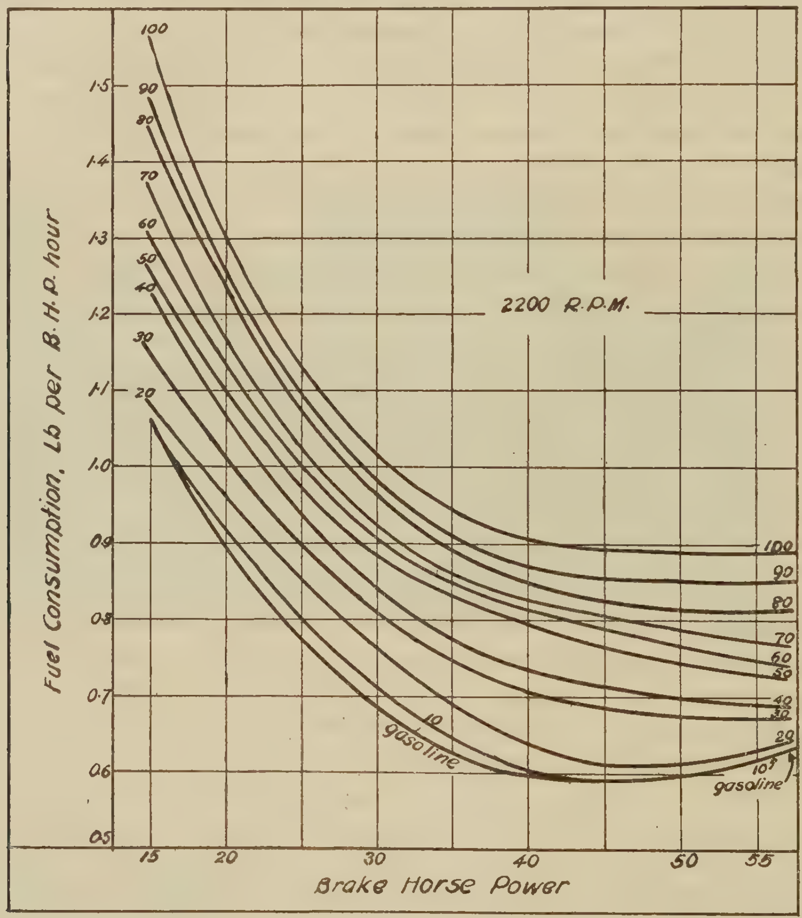

Chart 1.—Performance curves at 2200 r.p.m. (Number indicates percentage of B–dehydrated alcohol in the mixture by volume.)

The same jets that were used in the tests using gasoline were employed in those using the mixture containing 10 per cent dehydrated alcohol. No change was made because the engine could run smoothly and steadily with these jets under the same conditions of test. As the percentage of dehydrated alcohol in the mixture was further increased, relatively larger jets were employed in order to make the engine develop a maximum power that was nearly the same for all fuels.

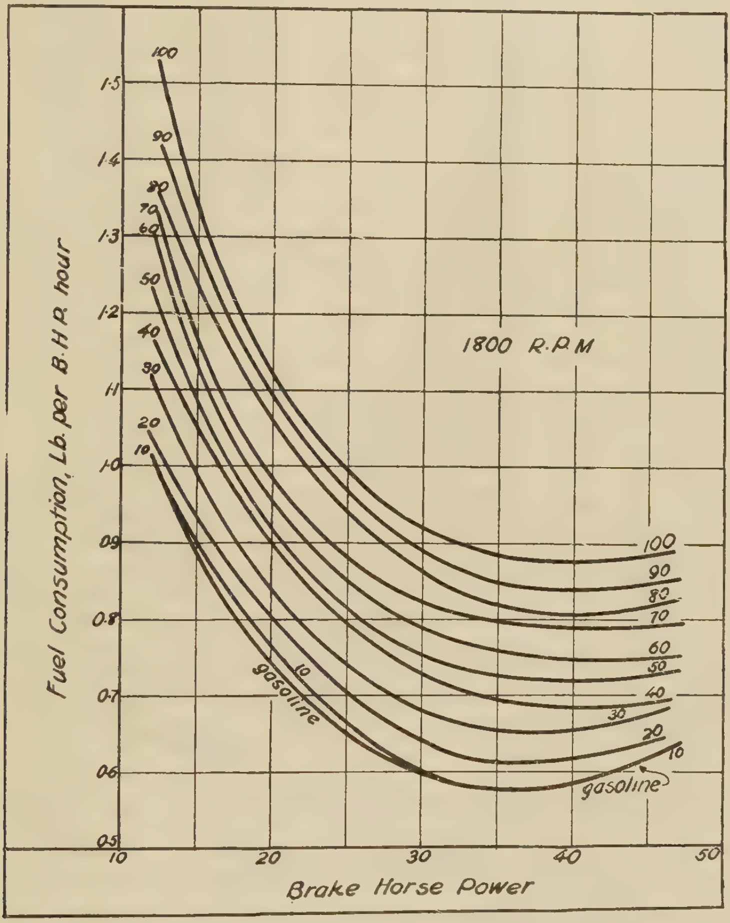

Chart 2.—Performance curves at 1800 r.p.m. (Number indicates percentage of B–dehydrated alcohol in the mixture by volume.)

A study of the results given in tables 1 and 2 and in charts 1 to 7 shows:

A. *Full load.*

1. That above 1400 r.p.m. no difference in consumption was found between gasoline and the mixture containing 10 per cent dehy-

drated alcohol. Below 1400 r.p.m. the mixture was a little more economical than gasoline.

2. That the average increase in fuel consumption at all speeds was about 4 per cent per every 10 per cent increase of dehydrated alcohol in the mixtures containing 10 to 40 per cent dehydrated alcohol and about 5 per cent for the mixtures containing over 40 per cent.

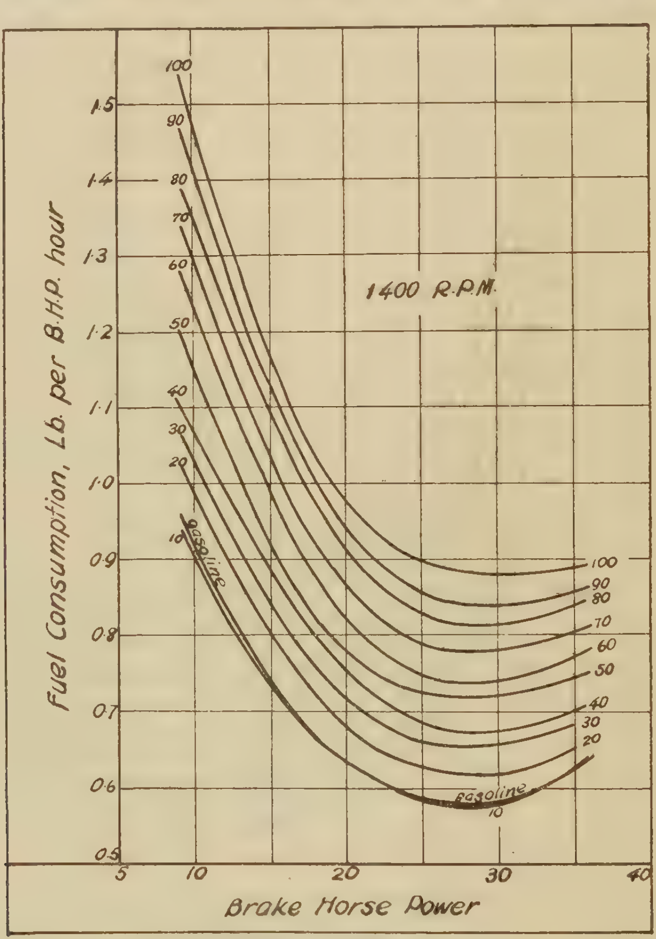

Chart 3.—Performance curves at 1400 r.p.m. (Number indicates percentage of B–dehydrated alcohol in the mixture by volume.)

3. That gasoline, dehydrated alcohol, and the mixture containing 10 per cent dehydrated alcohol were most economical at 1800 r.p.m. The other fuels were most economical at 2200 r.p.m.

B. *Three-fourths load.*

1. That at practically all speeds it was more economical to use the mixture containing 10 per cent dehydrated alcohol than to use gasoline.

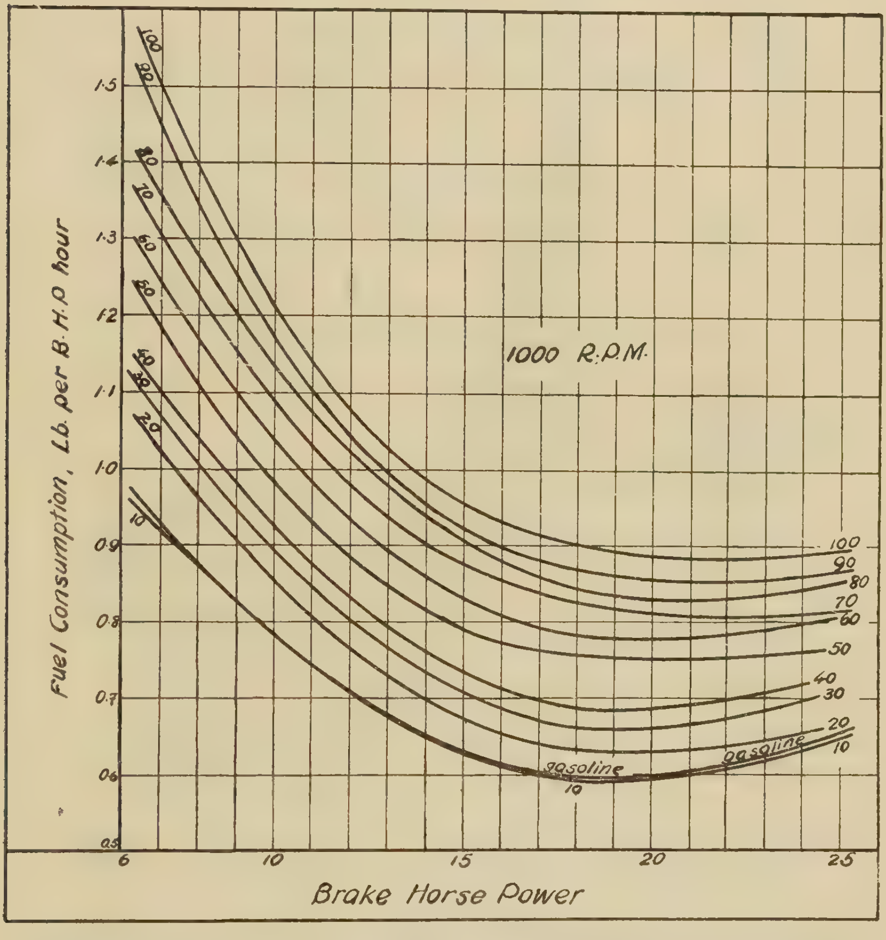

Chart 4.—Performance curves at 1000 r.p.m. (Number indicates percentage of B–dehydrated alcohol in the mixture by volume.)

2. That the average rate of increase of fuel consumption in all mixtures was about 5.7 per cent per every 10 per cent increase of dehydrated alcohol in the mixture.

3. That at 1800 r.p.m., engine operation was most economical with the use of gasoline, dehydrated alcohol, and the mixtures con-

taining 10 per cent and 20 per cent dehydrated alcohol. The other mixtures were most economical at about 1400 r.p.m.

C. *One-half load.*

1. That at one-half load, an increase in consumption was noted as the percentage of dehydrated alcohol in the mixture was increased.

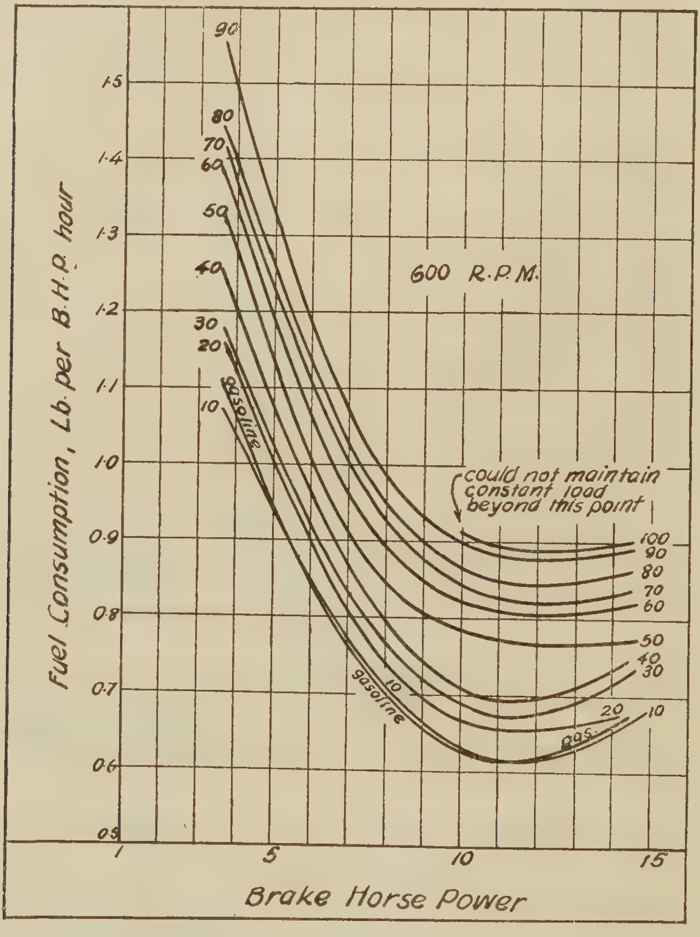

Chart 5.—Performance curves at 600 r.p.m. (Number indicates percentage of B–dehydrated alcohol in the mixture by volume.)

The fuel consumption with the use of the mixture containing 10 per cent dehydrated alcohol was about 3 per cent higher than with gasoline. An average increase of about 6 per cent in fuel consumption per every 10 per cent increase of dehydrated alcohol in the mixture was noted in the other fuels.

2. That the fuels containing not more than 60 per cent dehydrated alcohol were most economical at 1400 r.p.m. Those containing over 60 per cent were most economical at 1800 r.p.m. The most uneconomical speed for all fuels was at 600 r.p.m.

D. *One-fourth load.*

1. That the use of the mixture containing 10 per cent dehydrated alcohol gave just as much fuel economy as gasoline at 2200 and at 1800 r.p.m. Below 1800 r.p.m. this mixture was more economical than gasoline by about 1.5 to over 3 per cent.

2. That the rate of increase in consumption per every 10 per cent increase in dehydrated alcohol was about 7 per cent at speeds of 1000 and 1400 r.p.m. The average rate of increase for 2200, 1800, and 600 r.p.m. varied from 5 to 6 per cent.

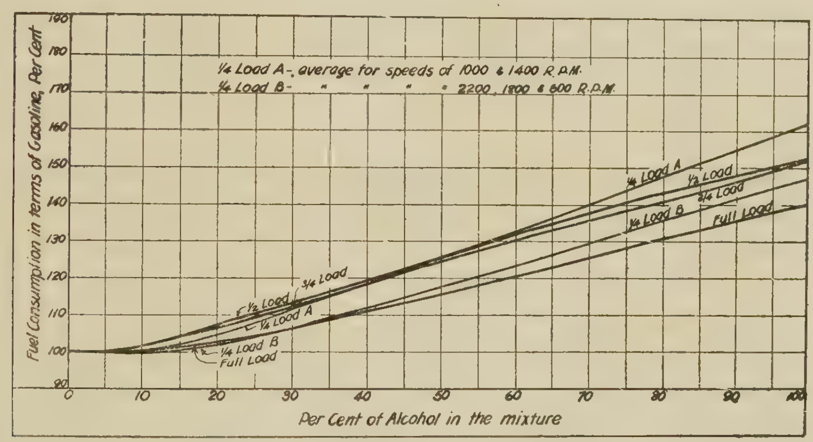

Chart 6.—Showing the relation between the percentage increase of fuel consumption in terms of gasoline and the percentage of B–dehydrated alcohol in the mixture by volume.

3. That engine operation using dehydrated alcohol was not constant at 600 r.p.m. At this speed all the fuels were most uneconomical.

Engine behavior. Engine operation on gasoline was characterized by very distinct detonation at all speeds, particularly at 600 and at 1000 r.p.m. on full throttle. With the mixture containing 10 per cent dehydrated alcohol, detonation was evident at 600 r.p.m., only. Constancy in operation using gasoline at full throttle could be maintained when the temperature of the cooling water was kept at about

180°F. or lower. The use of fuel mixtures containing at least 20 per cent dehydrated alcohol did not give any detonation during the full load test.

In general, the engine performance at three-fourths load was steadier than at full load. Operation on gasoline showed evidence of detonation at 2200 r.p.m. only. Detonation was not in evidence when dehydrated alcohol and fuel mixtures were used.

At one-half load constant operation could not be maintained at 600 r.p.m. using dehydrated alcohol because the engine jerked slightly after two minutes of running. At this load none of the fuels used detonated.

It was found on short tests at one-fourth load that engine operation at speeds of 350 to 500 r.p.m. could be maintained constant only when the fuels used were gasoline and mixtures containing as high as 30 per cent dehydrated alcohol. Mixtures containing more than 30 per cent dehydrated alcohol could not be run for more than three minutes at 400 r.p.m. and below without showing a marked decrease in the torque.

The dehydrated alcohol and gasoline used were found miscible in all proportions under the conditions in which they were mixed and tested.

CONCLUSIONS

Dehydrated alcohol of strength 98.5 per cent by volume, denatured with about 5 per cent sulfuric ether, proved to be an efficient and an excellent fuel for an eight-cylinder automobile engine having a compression ratio of 6.33:1. Mixtures of this alcohol and of gasoline in different proportions by volume were found miscible under the conditions in which they were tested. No sign of separation of the fuels was noted when the temperature of the liquid was lowered to 15°C.

Mixing dehydrated alcohol with gasoline minimized if it did not entirely suppress the tendency of gasoline to detonate. Engine operation at full throttle on gasoline showed evidence of detonation at all speeds. With the mixture containing 10 per cent dehydrated alcohol, detonation at this load was heard at the lowest running speed only.

No difficulty in starting from cold was experienced with any of the fuels used. When the engine was not yet warmed up, in order to maintain a steady running operation with the use of mixtures containing more than 40 per cent dehydrated alcohol, it was found to be necessary to close the choke partially for a few seconds.

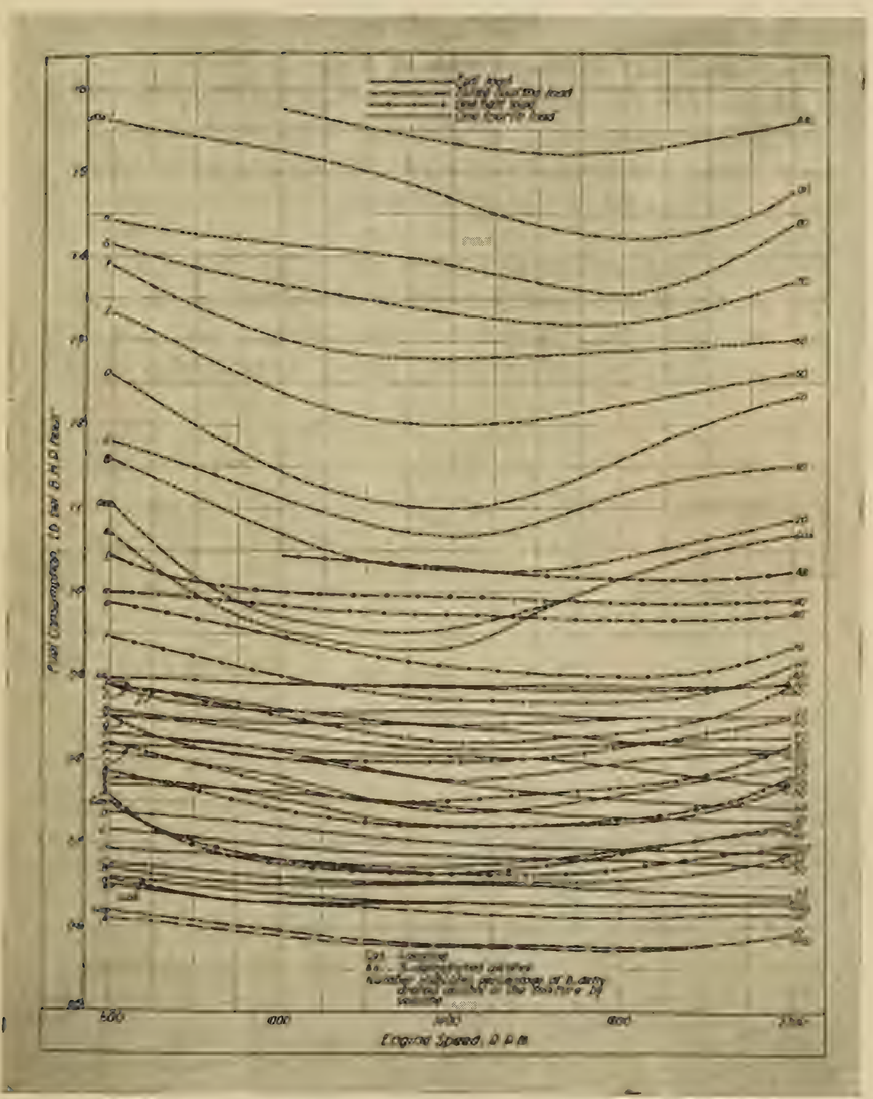

Chart 7.—Showing fuel economy at different speeds. (Number indicates percentage of B–dehydrated alcohol in the mixture by volume.)

Relatively greater power could be developed with the use of dehydrated alcohol and with mixtures containing at least 60 per cent dehydrated alcohol than with the use of gasoline. At speeds below 400 r.p.m., operation on mixtures containing at least 30 per cent dehydrated alcohol was characterized by jerky movements and by decreasing load after three minutes of running.

Fuel mixture containing 10 per cent dehydrated alcohol gave just as much fuel economy, if not more, as gasoline at all loads except at one-half where an increase in consumption was noted as the percentage of dehydrated alcohol in the mixture was increased. Using the mixture containing 10 per cent dehydrated alcohol as a basis, the percentage increase in fuel consumption per every 10 per cent increase of dehydrated alcohol in the mixture was about 4 to 5 per cent at full load, 5 to 6 per cent at three-fourths load, about 6 per cent at one-half load, and from 5 to 7 per cent at one-fourth load.

TABLE 1

Results of brake load and of fuel consumption tests at full throttle

FUEL	ENGINE SPEED	ENGINE POWER	TORQUE	BRAKE MEAN EFFECTIVE PRESSURE	CONSUMPTION FUEL
	r.p.m.	*b.h.p.*	*lb. - ft.*	*lb./sq. inch*	*lb./b.h.p./hr.*
Gasoline	2200	57.6	137.4	93.7	0.639
	1800	47.3	137.9	94.1	0.641
	1400	36.2	135.7	92.6	0.647
	1000	25.4	133.3	91.3	0.663
	600	14.4	126.0	85.9	0.678
10% Alcohol (Mixture A)	2200	56.8	135.6	92.6	0.634
	1800	46.5	135.6	92.6	0.636
	1400	35.9	134.6	91.9	0.644
	1000	25.4	133.4	91.0	0.657
	600	14.9	130.0	89.0	0.684
20% Alcohol (Mixture B)	2200	56.4	134.5	91.9	0.638
	1800	45.3	133.6	91.2	0.646
	1400	35.0	131.2	89.7	0.651
	1000	24.5	128.6	87.9	0.661
	600	14.4	126.0	85.9	0.680
30% Alcohol (Mixture C)	2200	57.1	135.7	92.7	0.673
	1800	46.5	135.6	92.6	0.684
	1400	35.0	131.2	89.7	0.685
	1000	24.6	129.1	88.2	0.708
	600	14.6	127.7	87.2	0.740
40% Alcohol (Mixture D)	2200	57.6	137.4	93.7	0.687
	1800	46.5	135.6	92.6	0.697
	1400	35.6	133.4	91.1	0.708
	1000	24.2	127.0	86.7	0.720
	600	14.4	126.0	85.9	0.750
50% Alcohol (Mixture E)	2200	57.3	136.7	93.3	0.724
	1800	47.3	137.9	94.1	0.736
	1400	36.1	135.3	92.4	0.754
	1000	24.6	129.1	88.2	0.765
	600	14.7	129.1	88.2	0.776
60% Alcohol (Mixture F)	2200	57.6	137.4	93.7	0.739
	1800	47.3	137.9	94.1	0.752
	1400	36.5	136.8	93.4	0.789
	1000	24.8	130.1	88.8	0.803
	600	14.6	127.7	87.2	0.822
70% Alcohol (Mixture G)	2200	57.7	137.6	93.9	0.766
	1800	47.4	138.2	94.3	0.797
	1400	36.2	135.7	92.6	0.812
	1000	25.4	133.3	91.3	0.815
	600	14.5	126.8	86.6	0.841
80% Alcohol (Mixture H)	2200	57.3	136.7	93.3	0.817
	1800	47.1	137.4	93.8	0.828
	1400	35.6	133.4	91.1	0.843
	1000	25.2	132.3	90.4	0.857
	600	14.5	126.8	86.6	0.869
90% Alcohol (Mixture I)	2200	57.8	138.0	94.2	0.851
	1800	47.2	137.6	94.0	0.854
	1400	35.9	134.6	91.9	0.861
	1000	25.4	133.3	91.3	0.870
	600	14.6	127.7	87.2	0.898
B-dehydrated alcohol	2200	57.7	137.6	93.9	0.889
	1800	46.5	135.6	92.6	0.890
	1400	35.9	134.6	91.9	0.892
	1000	25.4	133.4	91.0	0.894
	600	14.6	127.7	87.2	0.904

TABLE 2

Fuel economy at full and at fractional loads

LOAD	ENGINE SPEED	ENGINE POWER	FUEL					
			Gasoline	10% Alcohol (Mixture A)	20% Alcohol (Mixture B)	30% Alcohol (Mixture C)	40% Alcohol (Mixture D)	50% Alcohol (Mixture E)
	r.p.m.	*b.h.p.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*
Full load[a]	2200	56.0	0.630	0.630	0.637	0.672	0.688	0.726
	1800	46.0	0.627	0.627	0.645	0.681	0.693	0.731
	1400	35.0	0.629	0.629	0.651	0.685	0.700	0.743
	1000	24.0	0.640	0.630	0.652	0.697	0.720	0.761
	600	14.0	0.661	0.652	0.672	0.717	0.737	0.770
Three-fourths load	2200	43.6	0.592	0.592	0.615	0.688	0.715	0.771
	1800	35.4	0.577	0.573	0.611	0.656	0.692	0.724
	1400	27.1	0.579	0.576	0.617	0.653	0.672	0.720
	1000	19.1	0.597	0.590	0.629	0.660	0.681	0.754
	600	10.8	0.620	0.611	0.658	0.676	0.694	0.778
One-half load	2200	29.1	0.697	0.722	0.780	0.818	0.848	0.887
	1800	23.6	0.669	0.686	0.728	0.767	0.814	0.831
	1400	18.1	0.663	0.663	0.719	0.751	0.796	0.818
	1000	12.7	0.682	0.685	0.740	0.770	0.800	0.851
	600	7.2	0.750	0.760	0.786	0.820	0.851	0.889
One-fourth load	2200	14.6	1.068	1.068	1.086	1.150	1.232	1.260
	1800	11.8	1.016	1.016	1.042	1.118	1.160	1.224
	1400	9.0	0.955	0.933	1.026	1.067	1.100	1.200
	1000	6.3	0.968	0.953	1.069	1.111	1.143	1.238
	600	3.6	1.106	1.070	1.158	1.180	1.260	1.334

[a] Values taken from plotted curves.

TABLE 2 (Continued)

LOAD	ENGINE SPEED	ENGINE POWER	FUEL				
			60% Alcohol (Mixture F)	70% Alcohol (Mixture G)	80% Alcohol (Mixture H)	90% Alcohol (Mixture I)	B-dehydrated Alcohol
	r.p.m.	*b.h.p.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*	*lb./b.h.p.—hr.*
Full load [a]	2200	56.0	0.743	0.769	0.812	0.851	0.888
	1800	46.0	0.752	0.791	0.822	0.850	0.886
	1400	35.0	0.772	0.804	0.838	0.857	0.888
	1000	24.0	0.801	0.811	0.843	0.857	0.889
	600	14.0	0.817	0.832	0.859	0.888	0.898
Three-fourths load	2200	43.6	0.791	0.807	0.826	0.851	0.890
	1800	35.4	0.758	0.797	0.819	0.848	0.882
	1400	27.1	0.738	0.775	0.812	0.841	0.886
	1000	19.1	0.780	0.810	0.832	0.860	0.890
	600	10.8	0.810	0.830	0.852	0.889	0.898
One-half load	2200	29.1	0.913	0.934	0.972	0.990	1.023
	1800	23.6	0.869	0.899	0.966	0.987	1.016
	1400	18.1	0.870	0.910	0.972	0.994	1.028
	1000	12.7	0.899	0.945	0.984	1.000	1.043
	600	7.2	0.945	0.986	1.000	1.043	—
One-fourth load	2200	14.6	1.301	1.370	1.438	1.479	1.561
	1800	11.8	1.288	1.321	1.356	1.423	1.525
	1400	9.0	1.278	1.333	1.389	1.467	1.533
	1000	6.3	1.301	1.365	1.413	1.523	1.572
	600	3.6	1.389	1.416	1.443	1.560	—

[a] Values taken from plotted curves.

CARBON-NITROGEN RATIOS OF SOME PHILIPPINE SOILS[1]

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WITH ONE TEXT FIGURE

It is generally recognized that the amount of organic carbon present in the soil is the most reliable measure of its organic matter content. Sometimes, the fertility of soils can be compared by using as a basis the organic carbon or the organic matter. For the average soil, the Wolff factor, 1.724, is used for converting organic carbon to organic matter.

For some time, total nitrogen was taken as the basis for calculating the organic matter content, but Waksman (1924) and Leighty and Shorey (1930) showed that the equation N × 20 = O. M. is not correct. They claim that organic matter calculations on the basis of organic carbon are more reliable.

Carbon-nitrogen ratios, according to some soil researchers, serve as a good index of micro-biological activity. Under normal conditions, the ratio was observed to be about 10. That either total organic carbon or total nitrogen may be used as an index of fertility in the examination of crop-bearing soils has already been established. Because of the rapidity with which organic carbon is determined, it should be preferred for routine work.

With the object of determining the carbon-nitrogen balance in some cultivated soils in the Philippines, and to get an idea of the fertility of the same, this work was undertaken.

REVIEW OF LITERATURE

McLean (1930) in his study of 50 British soils reported an average ratio of carbon to nitrogen of 10:1. The range of variation was 6.5 to 13.5:1. In his examination of 16 foreign samples, however, the range was from 2.0 to 23.0:1.

Rippel (1933) observed that the decomposition of any nitrogenous organic substance does not only depend upon its chemical constitution but also on the relation of the carbon to the nitrogen in the soil. He stated that "mineralization" of nitrogen (nitrification) in the soil takes place most favorably when the carbon nitrogen relation is at least lower than 20:1. Incidentally, in his studies on "mineralization" of nitrogen in culture media employing different bacteria and using casein and peptone as sources of nitrogen, and glucose and sucrose as carbohydrate sources, he found that the addition of carbohydrate substances decreased the amount of NH_3 formed while the bacterial count was increased. He found this to be true in another set of experiments using rice-, corn-, wheat-, pea-, linseed-, soybean-, and cotton-seed meals, having different percentages of nitrogen.

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[1] Experiment Station contribution No. 1108. Read before the Los Baños Biological Club, February 14, 1935. Received for publication, December 24, 1935.

[2] Mr. Lumang is at present connected with the Tobacco Board, Bureau of Internal Revenue.

Russel, as cited by McLean (1930), states that the ratios of carbon to nitrogen are not easily disturbed by the "net results" from various micro-biological activities. Under humid conditions, the ratio is about 10. He states further that the addition of non-nitrogenous organic matter such as starch, cellulose, or straw induces "nitrogen fixation which increases the amount of nitrogen at the expense of a much larger amount of carbon". The micro-biological assimilation of nitrates, however, reduces the amount of carbon, but "protects the nitrogen already present against loss. Both sets of processes decrease the carbon and increase the nitrogen, thus restoring the original ratio." The addition of nitrogenous organic matter tends to increase the proportion of nitrogen, but it "sets going a loss of gaseous nitrogen" and of nitrates which are produced as a result of a more rapid rate of nitrification. These losses of nitrogen are greater than of the carbon, so that the original ratio is again restored. McLean (1930) claims that there is no marked correlation between carbon-nitrogen ratios and fertility. He found further that C/N ratio decreases in a descending profile. The higher ratio in the top layer, he stated, is, no doubt, due to the presence of remains of plants.

Lunt (1930), in his investigations on forest litter and peats, found that the carbon content of these carbohydrate-rich materials is less than 58 per cent, and therefore the conversion factor, 1.724 (which assumes a carbon content of soil organic matter of 58 per cent), is too low. He suggests the factor 1.86.

According to Waksman (1924), when organic matter is added to the soil, either the formation of ammonia followed by nitrate accumulation, or, nitrogen starvation sets in; or, both will be about balanced. This condition will depend upon the total nitrogen content of the organic matter. If the nitrogen content is more than 2 or 2.5 per cent, no nitrogen starvation can set in but NH_3 will be liberated. If the nitrogen content of the organic matter is about 2 to 2.5 per cent, a "temporary nitrogen starvation" may set in lasting only for a few days; this is followed by the liberation of NH_3. If the nitrogen content is about 1 per cent, or less, a "last-long nitrogen starvation may set in, which may be corrected by the addition of inorganic nitrogenous fertilizer." The same was demonstrated by Hahn, as cited by Waksman (1924), who observed that the presence of .5 to 1.00 per cent of straw made possible the rapid utilization of the nitrogen in the soil; and, as a result, nitrogen deficiency ensued. When available nitrogen was added, the straw was rapidly decomposed with the result that the soil became normal again with a constant carbon-nitrogen ratio.

An investigation on the suitability of the dry combustion method for making a large number of total carbon determinations in soils was undertaken by Winters and Smith (1929). Their results showed that complete oxidation can be obtained by dry combustion using MnO_2 as an oxidizing agent. Their results were comparable to those obtainable by the wet combustion method. About 15 minutes were required for each determination.

Winters and Wimer (1931) devised a method which eliminated the cooling of the furnace between successive combustions making possible a larger number of determinations per unit time, and at the same time cutting down electric current consumption. They claim also that gas losses were reduced to the minimum and for this reason their method is to be preferred by less experienced analysts. They suggest an allowable variation of 1.1 per cent between duplicates.

Materials and methods

Soil samples. The samples used in this study are from soil areas in the islands of Luzon and Negros and represent sugar and rice lands.[3]

The 40 samples were obtained from eight areas as follows:

Alaminos area—seven samples; 1, and 9 to 14 inclusive.
Calauan area—eight samples; 15 to 22 inclusive.
San Pablo area—six samples; 2, 8, and 26 to 29 inclusive.
Santo Tomas area—six samples; 7, and 30 to 34 inclusive.
Nanhaya area—three samples; 4, 24 and 25.

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[3] The writers are indebted to the Department of Soils for the soil samples used in this study.

Mamatid area—five samples 35 to 39 inclusive.
Negros soils—four samples; 3, 5, 6, and 23.
Baguio soils—one sample; 40

Surface soils were used. They were taken at random in the particular areas with shovels, mattock pick or a soil auger. The surface soils ranged from 0 to 25 cm. in depth. The samples were dried in the laboratory and stored in mason jars for analysis. No information as to previous crops planted, tillage, methods of irrigation and drainage, etc., could be obtained for the individual samples. For the whole area from which the samples were obtained, general observations [4] were made on cropping practice, irrigation, etc.

Sampling. The air-dried soil samples were reduced to small particles by rubbing them with a pestle in a porcelain mortar. The reduced particles were then passed through a sieve having circular openings one millimeter in diameter. The sifted material was further reduced and passed through a 60 mesh sieve; it was then subsampled for the different determinations. The sub-samples were put in test tubes which were cork-stoppered.

Chemical analyses. Moisture, loss on ignition, total nitrogen and carbonate carbon were determined in accordance with the *Official and Tentative Methods of Analysis* of the Association of Agricultural Chemists of America (1931). In total nitrogen determination a modified ammonia bulb (Villanueva, 1933) was used.

Total carbon was determined according to the method of Winters and Wimer (1931) with some modification which was developed as a result of the considerable degree of variation between duplicate determinations under conditions obtainable in the laboratory of the Department of Agricultural Chemistry. This modification consisted in the use of suction alternately with oxygen from an oxygen pressure cylinder. The combustion train was essentially the same as that used by Winters and Wimer (1931) except that a three-way glass cock was placed between the oxygen-pressure cylinder and the bubble counter, the third lead of which was connected to a battery of KOH solutions for freeing the air from CO_2, as shown in figure 1. Another three-way glass cock was placed at the end of the combustion train after the bubble counter, one exit tube leading to the atmosphere, and the other to a water pump.

The general procedure of combustion was practically the same as the one adopted by Winters and Wimer (1931), except that instead of using a steady flow of oxygen for 15 minutes, oxygen was passed through the train for 5 minutes followed by suction for about the same length of time and then oxygen for the rest of the 15 minute period, that is, from the time the sample was introduced in the hot portion of the combustion tube (fig. 1). The rate of flow of the oxygen gas as well as CO_2- free air was about 4 bubbles per second. Regulation of the flow of air under suction was accomplished with the aid of the three-way glass cock at the pump-end of the combustion train. On stopping combustion, a constant, working pressure was maintained by cutting off the electric current and waiting for the time when the level of the liquid outside the jet of the bubble counter was the same as that inside before closing the Fischer tube.

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[4] These conditions were taken from unpublished theses carried out in the Department of Soils.

The method with the modification, under the conditions obtaining when this study was performed, introduced two distinct advantages:

(1) A smaller volume of oxygen was used for each determination.

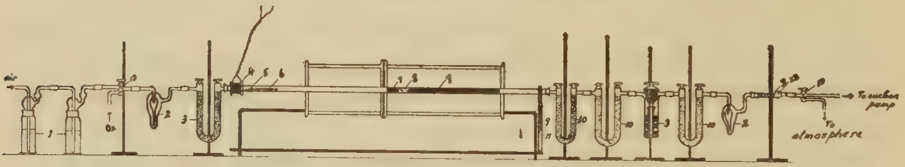

Fig. 1.—The combustion train. (1) Potassium hydroxide; (2) bubble counter; (3) ascarite; (4) coil; (5) pusher; (6) boat; (7) copper gauze; (8) CeO_2 on pumice; (9) zinc; (10) desicchlora; (11) cooling U-tube; (12) soda lime; (13) three-way glass cock.

(2) More concordant results between duplicates were obtained.

Data supporting the second of these two advantages claimed will be presented in a later paper.

RESULTS AND DISCUSSION

The results of the chemical analyses based on the oven-dry samples are given in table 1. The moisture content of the air-dry soil samples was below 10 per cent. It ranged from 2.97 to 9.53 per cent.

As shown in this table the organic carbon content of the soils analyzed was practically uniform. Samples 31 and 33 of the Sto. Tomas Area and 35 and 37 of the Mamatid Area had percentages below 1.00 per cent; and, samples 3 and 5 of the Negros soils, sample 19 of Calauan Area, and sample 4 of Nanhaya Area had percentages above 2.5 per cent. The organic carbon content of the rest of the samples was from 1.00 to 2.5 per cent.

The total nitrogen content ranged from 0.042 per cent corresponding to sample 31, an eroded phase of the Sto. Tomas Area, to 0.473 per cent for sample 3 of the Negros soils. Judging from the percentages of organic carbon and total nitrogen, sample 3 of the Negros Soils, compared with the others, was exceptionally rich.

The carbon-nitrogen ratio ranged from 8.51 to 21.14 corresponding to samples 33 and 31, respectively, both of which are from the same area. As stated previously, sample 31 was an eroded phase. It has the minimum nitrogen content and a low percentage of organic carbon. The extraordinarily high carbon-nitrogen ratio of sample 31 was probably due to its eroded condition, and, to possible factors not favorable for micro-biological activity. This high ratio clearly indicates nitrogen deficiency; the carbon-containing material probably consisted largely of remains of plants.

A study of the carbon nitrogen ratio of the rest of the samples reveals that only a few samples had carbon-nitrogen ratios very much above 10 (samples 3, 26, and 35). Only a few were below this figure. This suggests that the average soil studied was under a normal carbon-nitrogen balance and micro-biological activity. This may be true normally with Philippine soils. The normal ratio according to Waksman (1924) can be restored by the addition of nitrogenous inorganic fertilizer when nitrogen is wanting, that is, if the ratio is abnormally high. The average for the 40 samples was 11.80.

The percentages of organic matter calculated by multiplying the organic matter by 1.724 are certainly very low compared with the percentages of "loss on ignition." The range was from 1.174 per cent to 12.489 per cent, corresponding to samples 33 of the Sto. Tomas Area and 3 of the Negros Soils, respectively.

The percentages of "loss on ignition" ranged from 6.79 to 20.42 per cent corresponding to samples 6 and 3, respectively, both of the Negros Soils.

The percentages of nitrogen to organic matter were calculated, and from the results obtained, it may be seen that in only one case was the percentage about 2.5 per cent; this probably indicates a positive nitrogen deficiency. This figure corresponds to sample 31 which had a C/N ratio of 21.14. The sample containing more than 3.00 per cent and below 4.00 per cent nitrogen in organic matter had carbon-nitrogen ratios above 15. These figures indicate that the carbon nitrogen balance and micro-biological activity were not normal. Comparing the percentages of organic with total carbon, it is evident that there was an insignificant amount or no carbonate carbon in the soils studied.

SUMMARY AND CONCLUSIONS

In this study, 40 samples of Philippine surface soils representing different soil areas in Luzon and Negros were analyzed. The samples were either loam or clay soils with a predominating color of brown of different shades.

From the results of the chemical analyses, the following may be deduced:

1. Only one sample (sample 31 of the Sto. Tomas Area) had an abnormally high carbon-nitrogen ratio; these results probably indicate a high degree of nitrogen starvation. Sample 31 was an eroded phase and probably a poor soil also.

2. One sample of the Negros Soils had an exceptionally high organic carbon and total nitrogen contents. Although it was an unusually rich soil, as judged from the percentages of total nitrogen and organic carbon, the carbon-nitrogen ratio was very much above normal, a result which confirms the observations of previous workers that carbon-nitrogen ratios are not good indices of soil fertility.

3. A majority of the soil samples studied were normal as to their carbon-nitrogen ratio. They are not, however, very rich soils as indicated by their total nitrogen and total organic carbon contents. Sample 3 of the Negros Soils with a high carbon nitrogen ratio (15.32) had about twice as much nitrogen and more than two times the total organic carbon of the best soil with a normal carbon-nitrogen ratio. Thus, it appears very reasonable to consider both organic carbon and total nitrogen in addition to C-N ratio in evaluating the fertility of a soil.

In another investigation which the senior author proposes to undertake, organic carbon and total nitrogen determinations will be made simultaneously with pot experiments to determine whether the determination of one or the other will be of value in practical agriculture.

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TABLE 1

Showing the loss on ignition, organic carbon, total carbon, organic matter, total nitrogen, carbon-nitrogen ratio and nitrogen to organic matter of some Philippine soils based on the oven-dry samples

SAMPLE NO.	A[a]	LOSS ON IGNITION	ORGANIC CARBON	TOTAL CARBON	ORGANIC MATTER [b]	TOTAL NITROGEN	CARBON NITROGEN RATIO	NITROGEN TO ORGANIC MATTER
		per cent	*per cent*	*per cent*	*per cent*	*per cent*		*per cent*
1	33–1	12.16	1.750	1.753	3.017	.165	10.61	5.47
12	31–1	10.07	1.460	1.463	2.483	.136	10.37	5.48
14	29–1	11.96	2.052	2.055	3.538	.190	10.80	5.37
9	28–1	12.67	2.037	2.043	3.512	.193	10.55	5.50
11	30–1	12.04	1.713	1.716	2.953	.156	10.98	5.28
13	26–1	8.50	1.502	1.510	2.589	.131	11.47	5.06
10	27–1	12.02	1.740	1.743	2.800	.204	8.53	7.29
15	37–1	11.43	2.014	2.014	3.472	.187	10.77	5.39
16	38–1	10.75	1.392	1.395	2.400	.147	9.47	6.13
17	4–1	11.97	2.064	2.068	3.558	.237	8.71	6.66
20	48–1	8.78	1.959	1.962	3.377	.176	11.13	5.21
18	2–1	8.88	1.948	1.951	3.358	.169	11.53	5.03
19	1–1	12.65	3.152	3.156	5.434	.288	10.94	5.30
21	11–1	10.23	1.527	1.531	2.633	.157	9.71	5.96
22	46–1	12.31	1.903	1.906	3.281	.145	13.12	4.42
2	40–1	8.08	1.803	1.806	3.108	.144	12.52	4.63
8	34–1	11.37	2.042	2.046	3.520	.175	11.67	4.97
26	44–1	7.38	1.608	1.612	2.772	.103	15.61	3.72
27	35–1	10.06	1.577	1.582	2.719	.134	11.77	4.93
29	43–1	7.36	1.323	1.326	2.281	.126	10.50	5.52
28	41–1	10.05	2.057	2.060	3.546	.179	11.49	5.05
7	25–1	11.33	1.551	1.551	2.674	.179	8.66	6.69
30	19–1	9.08	1.675	1.679	2.888	.123	13.62	4.26
32	18–1	13.18	1.863	1.867	3.212	.133	14.01	4.14
31[c]	21–1	10.25	.888	.888	1.531	.042	21.14	2.74
33	—	8.43	.681	.681	1.174	.080	8.51	6.81
34	—	9.03	1.446	1.450	2.493	.125	11.57	5.01
4	5–1	13.03	2.941	2.946	5.070	.272	10.81	5.36
24	8–1	11.52	1.254	1.254	2.162	.143	8.77	6.61
25	7–1	13.72	2.136	2.139	3.682	.173	12.35	4.70
35	16–1	7.85	.959	.959	1.653	.063	15.22	3.81
36	12–1	13.66	2.276	2.279	3.924	.185	12.30	4.71
37	14–1	8.78	.928	.928	1.600	.093	9.98	5.81
38	15–1	10.58	1.429	1.432	1.464	.106	13.48	4.30
39	17–1	8.64	1.142	1.142	1.969	.123	9.28	6.25
3	24–A	20.42	7.244	7.253	12.489	.473	15.32	3.79
5	6–A	12.33	3.042	3.046	5.244	.215	14.15	4.10
6	3–A	6.79	1.604	1.604	2.765	.119	13.48	4.30
23	2–A	9.69	2.065	2.065	3.560	.139	14.86	3.90
40	18–A	13.58	1.819	1.824	3.136	.153	11.89	4.88
Average							11.80	5.11

[a] Department of Soils' sample number.
[b] Organic carbon × 1.724.
[c] Eroded phase.

A FURTHER STUDY OF THE COMPARATIVE FEEDING VALUE FOR GROWING PIGS OF COARSE AND STANDARD RICE BRAN [1]

TEOFILO B. RIVERA

INTRODUCTION

The work herein presented is a continuation of the study on the feeding value of coarse rice bran reported by Roberto H. Tirol in 1933 [2]. Interest in conducting the present investigation was aroused by the findings of Tirol. He reported that the ration mixture was only 38 per cent efficient when coarse rice bran was used to replace 60 parts of fine rice bran in ration; but when 30 parts or only half as much fine rice bran was replaced by coarse rice bran weight for weight, the ration proved to be 67 per cent efficient. This finding suggested the question: would the pigs have done better or worse on the smaller 70 per cent ration with no coarse rice bran at all? This question could not be answered from Tirol's data as in his study there was no lot of pigs on 70 per cent ration or with only 30 parts of fine rice bran in the grain mixture. And Tirol's is the only study on coarse rice bran that has been made in this College.

The use of this by-product for feeding purposes is becoming more popular owing to the rapid increase in the number of small rice mills which produce this kind of rice bran. Because of this situation it is important to study further the use of rice bran as a feed.

The coarse rice bran comes from small mills commonly called *kiskisan*. These mills mill the rice in one process mixing the hulls, bran, polish, germs and broken grains altogether. The standard rice bran comes from larger mills called *cono*. In this kind of mill the hull is not ground but separated and discarded so that the bran is a fairly distinct product.

Tirol (1933) experimenting on feeding three rations, each containing 60 per cent rice bran, to growing pigs reported that, based on the amount of feed required per unit of gain, the concentrate ration containing coarse rice bran was 38 per cent as efficient as the ration containing fine rice bran; the ration containing one-half fine rice bran and one-half coarse rice bran was, however, 67 per cent as efficient as the ration with only fine rice bran.

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[1] Thesis presented for graduation, 1935, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 487; Experiment Station contribution No. 1109. Prepared in the Department of Animal Husbandry under the direction of Dr. Mariano Mondoñedo.

[2] TIROL, ROBERTO H. 1933. Comparative feeding value of coarse and standard rice brans for growing pigs. The Philippine Agriculturist 21: 628–638.

From the standpoint of feed cost per kilogram gain the ration containing only coarse rice bran was found to cost 92 per cent more than the fine rice bran ration; but the coarse and fine rice bran ration cost only 29 per cent more. Tirol observed that while coarse rice bran is an unsuitable feed, the degree of unsuitability became less marked as the pigs grew older, provided they were given a sufficient amount of other feeds to make the ration fairly well balanced.

Object of the present work

The object of this study was to determine whether or not Tirol's standard ration which contained 60 parts by weight of fine rice bran, if modified by reducing these 60 parts to 30 parts would prove as efficient as the ration with 30 parts fine rice bran and 30 parts coarse rice bran.

Time and place of the present work

This work was begun on August 13, 1933 and closed on March 11, 1934 covering 210 days. It was conducted in the Swine Division of the Department of Animal Husbandry of the College of Agriculture of the University of the Philippines, Los Baños.

MATERIALS AND METHODS

Materials

Animals used. Eighteen Berkjala weanling pigs were used. They were about two and one-half months old when the experiment was started. They were fairly uniform in size and condition.

Feeds used. The feeds used were ground corn, coarse rice bran, standard rice bran, copra meal, and dried shrimps. The analysis of the feeds compared in this study is:[a]

	Standard rice bran	*Coarse rice bran*
Moisture	9.20	10.27
Fats or ether extract	13.89	4.26
Ash	10.11	15.86
Protein (N. × 6.25)	12.38	5.41
Crude fiber	9.72	25.57
Carbohydrates N. F. E.	44.70	38.63

[a] Analyzed in the Agricultural Chemistry Department, College of Agriculture.

The proportion by weight of the feeds in the rations for each lot for the different periods was:

First 70-day period	Lot I	Lot II	Lot III
Fine rice bran	60	30	30
Coarse rice bran	0	0	30
Corn	15	15	15
Copra meal	17	17	17
Shrimps	8	8	8
Second 70-day period			
Fine rice bran	60	30	30
Coarse rice bran	0	0	30
Corn	20	20	20
Copra meal	15	15	15
Shrimps	5	5	5
Third 70-day period			
Fine rice bran	60	30	30
Coarse rice bran	0	0	30
Corn	25	25	25
Copra meal	13	13	13
Shrimps	2	2	2

The average prices of the feeds used at the time of the feeding trial were:

Fine rice bran	3.6	centavos	a	kgm.
Coarse rice bran	1.1	"	"	"
Corn	4.3	"	"	"
Copra meal	2.7	"	"	"
Shrimps	15.1	"	"	"

Mineral mixture used

Common salt	45 parts
Ground corncob charcoal	45 "
Slaked lime	10 "
Total	100 parts

To every 100 kilograms of the feed mixture used, 2 kilograms of the mineral mixture were added.

Nature of feeds under study. The following average percentage of products and by-products were furnished by Prof. V. B. Aragon of the Department of Agronomy. They were obtained from data on averages of the milling of palay of two varieties, Hambas and Ramai.

	Large rice mill (*cono*)	*Small rice huller* (*kiskisan*)
Polished rice	64.32 per cent	59.25 per cent
Rice bran	10.21 " "	37.11 " "
Hulls	25.23 " "	1.00 " "
Shorts (binlid)	0.23 " "	2.59 " "
Impurities and waste	0.01 " "	0.05 " "

The coarse rice bran from the *kiskisan* mill contains approximately 60 per cent hulls and 40 per cent bran.

METHOD OF EXPERIMENTATION

Allotment of pigs

In making up the three lots of pigs for the experiment, careful consideration was given that the lots should be as uniform as possible in the sex, weight, age and condition of the animals.

Feeding

All the lots were given as a ration a mixture of feeds that contained the same amounts of corn, copra meal and shrimps. These feeds constituted 40 parts of the whole ration. Lot I pigs, the control lot, received in addition to the feeds mentioned above, 60 parts fine rice bran; lot II, 30 parts fine rice bran; lot III, 30 parts coarse rice bran and 30 parts fine rice bran.

Duration of the experiment

The feeding trial was carried for 210 days divided into three 70-day periods. No re-allotment of the pigs was made as the experiment passed from one period to another.

CARE AND MANAGEMENT

During the first period the pigs after each feeding were driven into a good growth of camote pasture. At noon they were driven into the hog house for watering after which they were driven back to the pasture. During inclement weather, however, for protection, the pigs were kept in the hog house overnight and in some instances during some parts of the day.

At the end of the first period, October 22, 1933, the pasture was almost depleted of camote vines. The animals were then transferred to a paddock bare of vegetation. Here, they were supplied camote soilage at the rate of one per cent of their total live weight at noon. The pigs remained in this enclosure up to the end of the experiment. During the third 70-day period they did not receive any kind of forage. The pigs in each lot were trained to go into their respective pens at feeding time. The treatment for each lot was as uniform as possible throughout each period, except for the difference in rations.

OBSERVATIONS

First 70-day period

Lot I pigs (60 parts fine rice bran lot) consumed the most feed and made the most rapid gain. All of the pigs were healthy and in good condition throughout the period.

Lot II pigs (30 parts fine rice bran lot) were equally healthy. They consumed their ration readily and finished it in the shortest time, the ration being limited. They were fairly uniform in growth and development, although at the end of the period they were smaller than the pigs of lot I. They were inclined to pasture more closely than lot I or lot III pigs.

Lot III pigs (30 parts coarse and 30 parts fine rice bran lot) appeared larger but more spare in condition than those of lot II. All the pigs of this lot were healthy.

Second 70-day period

Lot I pigs were all in good condition. They continued to consume the largest amount of feed. All had a good appetite.

Lot II pigs were in good health and condition, but they appeared more restless than those of the other lots. They, again, took the shortest time to consume their ration.

At the end of this period, lot III pigs were observed to have coarser hair and skin than the pigs of the other two lots. They were medium in condition.

Third 70-day period

Lot I pigs made decidedly the greatest gains and consumed the largest amount of feed. They appeared the best in health and condition. They were contented and appeared at the end of the experiment more refined and more uniform in size and condition than the pigs of the other lots.

Lot II pigs, as a whole, looked smaller than those of the other lots. They showed by their behavior that they were not contented. They were, however, active and in good healthy condition.

Lot III pigs looked poorer in quality. They were smaller than lot I pigs but were larger than those of lot II.

RESULTS

Results obtained during the partial and entire feeding periods follow:

Summary of results

First 70-day period	Lot I	Lot II	Lot III
Average initial weight of pigs in kgm.	10.88	10.97	10.98
Average daily gain in weight in kgm.	.31	.24	25
Feed consumed per kgm. gain	3.24	2.62	3.73
Feed cost per kgm. gain	₱0.15	₱0.13	₱0.14
Second 70-day period			
Average initial weight of pigs in kgm.	32.27	28.00	28.27
Average daily gain in weight in kgm.	.37	.24	.26
Feed consumed per kgm. gain	4.08	3.37	5.09
Feed cost per kgm. gain	₱0.17	₱0.15	₱0.17
Third 70-day period			
Average initial weight of pigs in kgm.	58.07	45.00	46.50
Average daily gain in weight in kgm.	0.35	0.21	0.28
Feed consumed per kgm. gain	5.79	5.19	6.64
Feed cost per kgm. gain	₱0.23	₱0.21	₱0.21
Combined 210-day period			
Average initial weight in kgm.	10.88	10.97	10.98
Average final weight in kgm.	82.83	59.37	65.87
Average gain per pig in kgm.	71.95	48.40	54.89
Average daily gain in weight in kgm.	.34	.23	.26
Feed consumed per kgm. gain	4.42	3.65	5.19
Feed cost per kgm. gain	₱0.18	₱0.16	₱0.17

DISCUSSION OF RESULTS

First 70-day period

By reference to the summary of results, it may be seen that lot I (full feed on fine rice bran ration) made an average daily gain of .31 kgm.; lot II (70 per cent full feed on half fine rice bran ration) .24 kgm.; and lot III (full feed on half fine and half coarse rice bran ration) .25 kgm. Expressing the differences in percentage and taking lot I as 100 per cent, lot II was only 80 per cent efficient and lot III, 81 per cent.

Between lots II and III there seemed to be no material difference, but between these two lots and lot I, the latter was about 20 per cent the better. Under the system of feeding followed, it was apparently possible for lot II pigs to have made up to some extent the limited ration allowed them by pasturing more closely than the others.

From the viewpoint of feed consumed for a given unit of gain, lot I required 3.24 kgm. feed, lot II, 2.62 kgm. and lot III, 3.73 kgm.

to make one kilogram gain. In other words, lot II required only 81 per cent of the amount of feed required by lot I to make the same amount of gain. Lot III, on the other hand, required 15 per cent more than that required by lot I. The most probable reason for lot II requiring less feed to make a given unit of gain was that this lot being limited in concentrate ration made up the difference by pasturing more closely and utilizing to greater advantage the limited feed received. It should be noted, however, that economy in feed consumption was accompanied by retarded growth and development.

Using the current prices of feed at the time of the feeding trial, as a basis the cost of feed for a kilogram gain in weight was 15 centavos for lot I, 13 centavos for lot II and 14 centavos for lot III.

Second 70-day period

During the second 70-day period, it may be noted that lot I made an average daily gain of 0.37 kgm., lot II, 0.24 kgm. and lot III, 0.26 kgm. Lot II, therefore, was only 65 per cent and lot III, 70 per cent as efficient as lot I.

Practically, the tendencies resulting from the differences in the rations given the three lots of pigs during the first 70-day period remained the same in the second period. If there was any difference, it was in degree only. Thus, between lots II and III, and between these two lots and lot I, the difference became more marked than during the first period.

From the point of view of feed consumed for a given unit of gain, lot I required 4.08 kgm., lot II, 3.37 kgm. and lot III, 5.09 kgm. of feed to make a kilogram gain. In other words, lot II required only 83 per cent of the feed required by lot I to make the same amount of gain. On the other hand, lot III required 25 per cent more feed than that required by lot I. As in the first period, lot II required the least feed and lot III the most.

Basing computations on the current prices of feed used at the time of the feeding trial, the feed cost per kilogram gain in weight was 17 centavos for lot I, 15 centavos for lot II and 17 centavos for lot III.

Third 70-day period

Lot I continued to be superior to the other lots in rapidity of gain. It made an average daily gain of 0.35 kgm., lot II, 0.21 kgm., and lot III, 0.28 kgm. Compared with lot I, lot II was only 60 per cent efficient, and lot III, 80 per cent.

The results obtained showed that the pigs in lot III continued to derive some benefit from the coarse rice bran in their ration. Lot II pigs which received practically the same ration as lot III, except for the absence of coarse rice bran, did not fare as well as the pigs in lot III throughout the whole feeding trial.

In feed consumption, lot I required 5.79 kgm., lot II, 5.19 kgm. and lot III, 6.64 kgm. feed to make one kilogram gain. For the same unit of gain, lot II required 90 per cent as much feed as lot I, and lot III, 115 per cent as much.

As to feed cost for a given unit of gain, lot I required 23 centavos worth of feed for every kilogram, lot II, 21 centavos and lot III, 21 centavos.

Combined 210-day period

The results obtained from the whole 210-day test show that lot I made the most rapid gain, and lot II, the slowest. Lot I made an average daily gain of 0.34 kgm., lot II, 0.23 kgm., and lot III, 0.26 kgm.

According to these results it appears that the reduction of the 60 parts fine rice bran used in the standard ration for lot I to 30 parts, or half as much, for lot II reduced the rate of gain by 32 per cent, but by replacing the 30 parts with the same amount of coarse rice bran, as was done for lot III, the rate of gain was reduced by only 24 per cent. In other words, in rate of gain, lot III was 8 per cent better than lot II. This was rather expected owing to the presence of fine rice bran contained in the coarse rice bran of the ration of lot III. That is, in the 30 parts of coarse rice bran added to the ration of lot III, 40 per cent or 12 parts are fine rice bran. Actually, lot III pigs were getting in addition to the 30 parts fine rice bran, 12 parts more of fine rice bran from the coarse rice bran or a total of 42 parts fine rice bran in their ration, while lot II received only 30 parts fine rice bran in their ration and lot I, 60 parts. The extra amount of fine rice bran, 12 parts or 12 per cent of the ration by weight, received by lot III may account for the 8 per cent superiority of lot III over lot II. Just what the influence of the hulls present in the coarse rice bran is could not definitely be determined in this work, but it may be surmised from the foregoing that it was harmful. It may be mentioned that lot II consumed 3.65 kgm. feed to make a kilogram gain, while lot III consumed 5.19 kgm. Out of the 5.19 kgm., 0.93 kgm. are hulls, leaving 4.26 kgm. of feed which is made up of the same constituents of the ration mixture given lot II. Apparently, lot III pigs, on account of the presence of hulls in the feed, consumed 0.61 kgm. or 17 per cent more feed without hulls than lot II. That is, rice hulls seemed to have some deleterious effects on the animals causing them to use more feed to make a kilogram gain.

Lot I consumed 4.42 kgm., lot II, 3.65 kgm. and lot III, 5.19 kgm. to make one kilogram gain. From this standpoint of amount consumed, lot II pigs gave better results than either lot I or III. This advantage, however, was secured at the expense of rapidity of growth and development, which were greatly retarded. If lot II pigs effected economy in feed for a given unit of gain it was not because the ration of lot II was superior to that of the other two lots, but with the ration being limited the pigs appeared to have had the ability to make better use of the limited ration and pasture supplement made available for them.

It may be of interest to note that a cavan or 33.5 kgm. of coarse rice bran used in this experiment cost 38 centavos or 1.13 centavos a kilogram. Were it not for the apparent deleterious effect of the hulls it is evident that coarse rice bran should sell only for the amount of fine rice bran it contains which is 40 per cent.

SUMMARY AND CONCLUSIONS

The results of the experiments reported in this paper may be summarized as follows:

1. Comparing the feeding value of a ration containing 30 parts fine rice bran, 70 per cent full-fed, with that of the standard ration containing 60 per cent fine rice bran, full-fed, the rate of gain in the former is only 68 per cent that of the latter.

2. With pigs receiving a ration containing equal parts of coarse and of fine rice bran, the rate of gain was 76 per cent as much as that of pigs getting the standard ration.

3. Basing calculation on the amount of feed consumed to make a kilogram gain, the ration containing 30 parts fine rice bran, 70 per cent full-fed, was 21 per cent more efficient than the standard ration but this efficiency was secured with a 32 per cent reduction in rate of growth.

4. The feed consumption to make a kilogram of gain in the ration containing equal parts of coarse and of fine rice bran was only 85 per cent as efficient as that of the standard ration.

5. Assuming the feed cost per kilogram gain of the standard ration lot as 100 per cent, the feed of the lot receiving the ration with 30 parts of fine rice bran added in the mixture was 14 per cent cheaper; the feed of the lot receiving the ration with 30 parts each of coarse and of fine rice bran in the mixture was 4 per cent cheaper.

6. The addition of coarse rice bran to the ration had a slight beneficial effect on the rate of gain in weight, which may be attributed to the fine rice bran it contains.

PROTEIN SUPPLEMENTS IN POULTRY RATIONS: VII. COMPARATIVE STUDIES ON THE INFLUENCE OF VARIOUS KINDS OF FISH MEALS IN RATIONS FOR CHICKS[1]

BANAO DALID

WITH ONE CHART

Fish meals as a supplement in poultry rations have been reported in South Africa to be inferior to meat meals or to dairy products (Anonymous, 1929). But in the United States, fish meal has been used extensively in poultry feeding for a number of years (Record *et al*, 1934). In the Philippines, fish meal has only recently been seriously considered as poultry feed and the poultrymen have no definite information as to the efficiency of the kinds that they use.

Of the protein supplement feeds in this country so far tested, shrimp meal has been found to be not only the most palatable, but also the most profitable for growing chicks (Fronda, Badelles and Padilla, 1934). But the relative scarcity of supply of this feed makes it beyond the reach of the average poultry raiser. As both local and foreign manufactured fish meals can now be purchased at reasonable prices, these meals were compared in the study herein reported, with the object of finding out which brand will produce the most economical results. The work was conducted from April 15, 1934 to January 19, 1935.

PLAN OF THE STUDY

Los Baños Cantonese chicks produced from the College flocks were used in this study. They were given a basal mash of three parts rice bran and one part corn meal. Different brands of fish meals were used as supplements in the proportion of 25 per cent of the total ration. Fronda and Kabigting (1934) found that 25 per cent of shrimp meal in the ration is the optimum amount to feed to growing chicks.

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[1] Thesis presented for graduation, 1935, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 486; Experiment Station contribution No. 1101. Prepared in the Poultry Husbandry Division. Department of Animal Husbandry under the direction of Dr. F. M. Fronda, Associate Professor of Poultry Husbandry.

Fish meals used. Imported and locally manufactured fish meals were tested. Two of the imported fish meals are of Japanese origin, two are from the United States, and the rest are local products.

The two Japanese fish meals are different, though both bear the commercial name "Mitsubishi." They are distinguished by their color and trade marks. In this paper they are designated as "MSK-black" and "MSK-red."

The "MSK-black" fish meal is light brown. Its trade mark is a black "MSK". It is rather coarse meal with a moderate fishy odor. No information was secured as to the kind or parts of fish manufactured into this product or the process of manufacture. The present price per sack of 45.45 kilograms (100 pounds) is ₱5.50. The guarantee of the manufacturer for protein content is that it is not less than 55 per cent.

The "MSK-red" fish meal is reddish brown with a red "MSK" trade mark. This meal is fine with a rather strong fishy odor. As with "MSK-black" no information as to the process of manufacture was secured. The price is the same as the "MSK-black".

The "Sardilene" fish meal is manufactured in the United States. The trade mark is "RED STAR (H-C)". The texture is fine and there is very little fishy odor. The color is light brown. No information as to the process of manufacture was secured. The price per sack of 45.45 kilograms (100 pounds) is ₱6.00. The guaranty is that the protein content is not less than 68 per cent.

The "Lighthouse" fish meal is also an American product. It has quite a strong fishy odor. It is reddish brown with medium fine texture. According to the agent for this product in Manila, it is manufactured from fresh sardines. The sardines are caught near the shores of San Francisco Bay not far from the factory. They are brought fresh to the factory and when partially dried they are crushed by rollers to remove the oil; then this product is dried in vacuum. The price is the same as the "Sardilene" fish meal. The protein content is not less than 68 per cent, according to the manufacturer.

The "Tuna" fish meal, according to the information from the donor of this feed, is manufactured by the Philippine Packing Corporation. It has the finest texture of all the fish meals used in this study. The color is light brown. It has a fairly strong fishy odor. As the name implies, it is manufactured from the tuna fish. No information as to the process of manufacture was obtained. The price per sack of 45.45 kilograms (100 pounds) is ₱5.50. The protein content, according to the agent, is guaranteed by the manufacturer to be not less than 58 per cent.

The "Surigao" fish meal is also manufactured in the Philippines. It is dark brown, with coarse texture. It has a strong fishy odor and is rather moist, showing improper drying. No price was quoted, as this fish meal was sent to the department for trial. No guaranty as to its protein content was given.

The "Estancia" fish meal is also a Philippine product. When mixing the ration uncrushed bones were frequently found in this meal. As this fish meal was sent to the Department for trial no price was quoted, nor was the protein content given.

The analysis of these different fish meals, and for comparison, that of shrimp meal, are given in the following table:[a]

BRANDS	MOISTURE	FATS (ETHER EXTRACT)	ASH	PROTEINS (N × 6.25)	CRUDE FIBER	CARBOHYDRATES	TOTAL
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Shrimp meal ……	14.55	2.61	19.73	55.61	4.24	3.26	100.00
"MSK-black" ……	10.86	3.59	13.86	62.60	0.70	8.39	100.00
"MSK-red" …….	10.92	6.95	17.49	53.72	0.63	10.29	100.00
"Sardilene" …….	10.34	3.04	17.38	58.63	0.55	10.06	100.00
"Lighthouse" ……	10.32	2.09	13.15	64.88	0.32	9.24	100.00
"Surigao" ……..	19.47	8.12	22.74	38.47	0.48	10.72	100.00
"Tuna" ………..	9.39	8.85	17.59	61.47	0.32	2.38	100.00
"Estancia" ……..	41.42	1.24	27.29	27.25	0.48	1.72	100.00

[a] Analyzed in the Department of Agricultural Chemistry.

Rations used. Three series of experiments were run covering a period of three months each. In the first set there were seven lots with 27 Los Baños Cantonese chicks to a lot. This series was started on April 15, 1934 and closed on July 14, 1934. The second set, eight lots, each lot with 23 Los Baños Cantonese chicks was started on July 19, 1934 and closed October 17, 1934. The additional lot in the second set was given a ration supplemented with "Tuna" fish meal which was received after the first series was started. In the third set, seven lots were run with 20 chicks to a lot. One of the lot was dropped because the "Estancia" fish meal lot was eliminated as the stock of this feed showed signs of putrefaction, probably owing to its high moisture content.

The ration that each of the lots received is shown in the following table:

RATIONS	LOTS							
	I	II	III	IV	V	VI	VII	VIII
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
Shrimp meal	25	..	..	..	..	..	..	..
"MSK-black"	..	25	..	..	..	..	..	..
"MSK-red"	..	..	25	..	..	..	..	..
"Sardilene"	..	..	..	25	..	..	..	..
"Lighthouse"	..	..	..	..	25	..	..	..
"Surigao"	..	..	..	..	..	25	..	..
"Tuna"	..	..	..	..	..	..	25[a]	..
"Estancia"	..	..	..	..	..	..	..	25[b]
Rice bran	56	56	56	56	56	56	56	56
Corn meal	19	19	19	19	19	19	19	19
Total	100	100	100	100	100	100	100	100

[a] **Two trials only, trials 2 and 3.**
[b] **Two trials only, trials 1 and 2.**

Feeding and care. The chicks in all the lots studied were raised in fireless brooders made of empty petroleum boxes. Each lot was provided with a feeding trough in which there was always feed, so that the chicks could feed at will. A range of 5 meters by 1.5 meters was provided for each lot so as to allow the chicks to feed on green feed and to roam around in the sunshine.

Records. The chicks were weighed individually on the day they were taken down from the incubator and weekly, thereafter, until they were 12 weeks old. Other observations as on mortality, feathering, vigor, health and the amount of feed charged to each lot were recorded.

RESULTS AND DISCUSSIONS

Growth of the chicks. It may be seen in table 1 and chart 1 that at the beginning of the experiment the mean weights of the chicks in all the lots were about the same. At the age of one week, the increases in weight in all the lots were fairly uniform. In the second week, however, differences in weights of the chicks in the different lots were becoming noticeable. At the end of the third week with the exception of lot VIII, "Estancia" lot, the weights of the chicks in the different lots were more than double the initial weights.

At the age of four weeks, lot VII, "Tuna" lot had the highest mean weight and lot VIII, "Estancia" lot had the lowest. At the age of eight weeks, however, lot II, "MSK-black" lot had the highest mean weight, and lot VIII, "Estancia", still had the lowest. Up to this age, lot I, shrimp meal lot, stood second in mean weight of the chicks, but at the age of twelve weeks, this lot had the highest mean weight and lot VIII, the lowest. Except in lots VI, "Surigao," and VIII, "Estancia", the chicks were observed to be healthy and vigorous.

By reference to chart 1 the relative difference of the mean weights of the chicks at the end of the experiment in the different lots may be seen. From this chart and from table 1, it may also be seen that in all the lots the greatest increase in the weights of the birds was toward the latter part of the experiment. Of all the lots studied it is apparent that lot VIII, "Estancia" lot, was the poorest. This condition was probably due to the deficiency of proteins in this kind of fish meal, which was shown by its analysis. Lot I, shrimp meal lot, with a mean weight of 634.5 ± 8.7120 grams was the best, and lot II, "MSK-black" lot, was second, with a mean weight of 605.5 ± 7.7690 grams; lot V, "Lighthouse" lot, third, with a mean weight of 602.6 ± 9.3295 grams. The mean weights of the chicks in the other lots at this age were: Lot IV, "Sardilene" lot, 592.8 ± 12.1231 grams; lot VII, "Tuna" lot, 566.2 ± 16.4900 grams; lot II, "MSK-red" lot, 514.1 ± 9.7176 grams and lot VI "Surigao" lot, 413.9 ± 10.8482 grams.

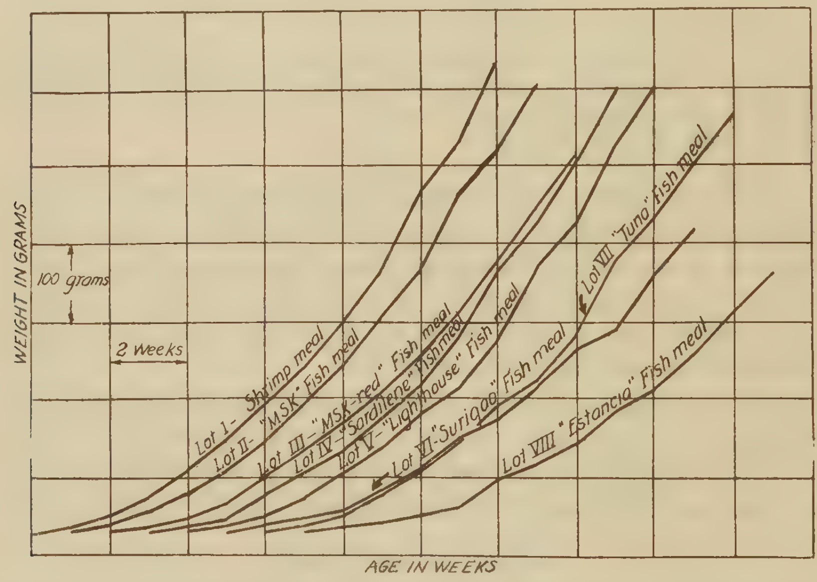

Chart 1.—Curves showing the mean weights of the chicks in the different lots studied at different ages.

When the differences between the weights of the chicks in the different lots at 12 weeks were treated statistically, it was found that when compared with lot I, shrimp meal weights, those in lot II, "MSK-black", IV, "Sardilene," and V, "Lighthouse", showed no significant differences; but those in lot III, "MSK-red", VI, "Surigao", VII, "Tuna", and VIII, "Estancia", were significantly inferior. The differences between lot II and lots IV, V and VII were insignificant. Lot II was decidedly superior to lots III, VI and VIII. Lot III was inferior to lots IV, V and VII, but superior to lots VI and VIII. Lot IV was significantly better than lots VI and VIII. When compared with lot IV, lots V and VII showed no significant differences. Lot V was decidedly better than lots VI and VIII, but was not significantly different from lot VII. Lot VI was inferior to lot VII but better than lot VIII, and lot VII was superior to lot VIII.

Allardyce, Henderson and Asmundson (1933), compared pilchard fish meals of different texture, color and process of manufacture and they observed that the coarser, light colored meals produced the heaviest chicks. The process of manufacture, according to these authors, was responsible for the different growth values of the fish meals that they studied. Undoubtedly, the same factor in addition to the differences in the nutrient contents of the fish meals used in the present study are responsible for the differences in the growth results obtained.

Mortality of the chicks. The mortality of the chicks in the different lots studied are shown in table 2. From this table it may be seen that lot VIII, "Estancia", had the highest mortality which is 42.11 ± 0.9207 per cent. Lots I, shrimp meal, II, "MSK-black", and III, "MSK-red", had about the same mortality, 28.78 ± 6.4289 per cent for lot I, 29.21 ± 4.1166 per cent for lot II, 27.81 ± 1.0592 per cent for lot III, the lowest for all the lots. The mortality in the other lots were: Lot IV, "Sardilene", 36.94 ± 3.9139 per cent, lot V, "Lighthouse", 32.48 ± 0.9183 per cent, lot VI, "Surigao", 30.02 ± 3.0786 per cent, and lot VIII, "Estancia", 33.50 ± 12.5356 per cent. Fronda, Badelles and Padilla (1930) reported 56 per cent mortality in the fish meal lot they studied. The mortality in each of the fish meal lots in this study was lower than these investigators report.

When the average percentages of mortality of the different lots were compared it was observed that, with a few exceptions, the differences were not significant. Lot II was 12.90 ± 4.2183 per cent better than lot III, a significant difference. Significant differences were also observed when lots III, V and VI were compared with lot VIII. In each case, lot VIII was significantly inferior.

Amount and cost of feeds. The amount of feeds charged to each lot is shown in table 3. When the charge to every lot was computed on the basis of 100 birds it was found that lot II was charged 212.2 kilograms, this being the highest. Lot IV was a very close second with 211.3 kilograms, and lot III was third with 206.2 kilograms. The lot that consumed the least feed for every 100 birds was lot VIII which consumed only 178.9 kilograms. Fronda, Badelles and Padilla (1930) found that the fish meal lot they studied consumed 212.2 kilograms of feed per 100 birds.

Taking as a base the amount of feeds charged for every 100 birds and using the current prices of the feeds used, and with weanlings selling at 60 centavos per kilogram, the returns above the cost of feeds from the different lots were computed. The data are shown in table 4. From this table it is apparent that lot I, shrimp meal, gave the highest returns, which was ₱27.42; lot II, "MSK-black", was second, with ₱25.61; and lot V, "Lighthouse", third, with ₱25.25. The returns from lots IV, "Sardilene" and VII, "Tuna", were almost the same, ₱23.77 for lot IV and ₱23.79 for lot VII. The returns from lot III, "MSK-red", was only ₱21.04. The returns for lots VI, "Surigao", and VIII, "Estancia", could not be determined as the donors of these fish meals did not report the price of the fish meal that they sent for trial.

It may be safe to recommend that, based on the results of this experiment, in the absence of shrimp meal, either the "MSK-black" fish meal or the "Lighthouse" fish meal may be used as a substitute. The "Tuna" fish meal, a Philippine product, because of its much lower cost, may be used also as a substitute for shrimp meal. The returns from the lot that received the "Tuna" fish meal ranked third among the seven fish meals studied.

SUMMARY AND CONCLUSIONS

Different kinds of fish meals, of both foreign and local manufacture, were compared in chick feeding, using shrimp meal as control. The results obtained may be summarized as follows:

1. Of the different kinds of fish meals compared with shrimp meal, using the rate of growth of the chicks as basis, "MSK-black" was the best and "Lighthouse" second, and "Estancia" the poorest.

2. The "MSK-black" lot consumed the largest amount of feed and the "Estancia" the least.
3. The highest mortality occurred in the "Estancia" lot.
4. Except in the "Estancia" and "Surigao" lots, the chicks were observed to be healthy and vigorous.
5. At 25 per cent protein supplement in the chick ration, either the "MSK-black" fish meal or the "Lighthouse" fish meal may be used satisfactorily as a substitute for shrimp meal.
6. The "Tuna" fish meal, a Philippine product, may also be used as a supplement in rations for chicks.

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TABLE 1

Showing the weekly mean weights of the chicks during the first twelve weeks after hatching

AGE	LOT I (25 PER CENT SHRIMP MEAL)		LOT II (25 PER CENT "MSK")		LOT III (25 PER CENT "MSK-RED")		LOT IV (25 PER CENT "SARDILENE")	
	Number of chicks	Mean weight	Number of chicks	Mean weight	Number of chicks	Mean weight	Number of chicks	Mean weight
		grams		*grams*		*grams*		*grams*
1 day	70	29.0 ± 0.4585	70	29.8 ± 0.4325	70	29.2 ± 0.7216	70	29.3 ± 0.1998
1 week	62	37.5 ± 0.4175	68	38.1 ± 0.4767	67	35.9 ± 0.4644	64	36.3 ± 0.5472
2 weeks ...	61	51.3 ± 0.7163	68	52.6 ± 0.9829	67	48.1 ± 1.0350	60	49.3 ± 1.0184
3 " ...	61	75.7 ± 1.6900	65	78.4 ± 1.8877	65	69.3 ± 1.6749	59	78.1 ± 2.0557
4 " ...	61	108.1 ± 2.3500	65	105.1 ± 2.8866	63	99.5 ± 2.7658	58	103.6 ± 2.8561
5 " ...	61	147.1 ± 3.7508	64	145.5 ± 3.8116	62	134.0 ± 3.7586	56	133.5 ± 3.5224
6 " ...	59	192.4 ± 4.5938	58	194.8 ± 4.0714	59	169.5 ± 4.2714	53	177.8 ± 3.9947
7 " ...	57	238.7 ± 5.7048	54	239.2 ± 4.6095	59	204.3 ± 5.1551	52	215.3 ± 4.2411
8 " ...	54	299.0 ± 6.1930	54	306.4 ± 5.3257	58	258.4 ± 6.1066	52	280.8 ± 6.8832
9 " ...	53	365.6 ± 7.9299	54	363.3 ± 6.0088	55	314.7 ± 8.0442	49	361.1 ± 8.2830
10 " ...	50	468.5 ± 8.7610	51	463.8 ± 7.5068	55	379.1 ± 8.1399	49	424.4 ± 10.5881
11 " ...	50	530.9 ± 8.4767	51	519.1 ± 8.6144	52	449.0 ± 10.2864	45	503.8 ± 11.3840
12 " ...	50	634.5 ± 8.7120	50	605.5 ± 7.7690	50	514.1 ± 9.7176	44	592.8 ± 12.1231

TABLE 1 (Continued)

AGE	LOT V (25 PER CENT "LIGHTHOUSE")		LOT VI (25 PER CENT "SURIGAO")		LOT VII (25 PER CENT "TUNA")		LOT VIII (25 PER CENT "ESTANCIA")	
	Number of chicks	Mean weight	Number of chicks	Mean weight	Number of chicks	Mean weight	Number of chicks	Mean weight
		grams		*grams*		*grams*		*grams*
1 day	70	29.1 ± 0.1778	70	29.2 ± 0.1874	43	29.5 ± 0.3278	50	29.6 ± 0.7011
1 week	65	37.5 ± 0.4894	62	36.7 ± 0.4307	41	39.7 ± 0.6879	43	36.6 ± 0.5429
2 weeks ...	64	50.9 ± 0.8975	61	48.8 ± 0.9617	35	51.5 ± 1.2815	43	43.0 ± 0.7593
3 " ...	63	72.6 ± 1.5130	58	59.7 ± 1.1042	33	79.2 ± 2.2321	42	52.0 ± 1.1141
4 " ...	62	105.1 ± 2.3996	56	84.4 ± 2.7473	33	109.0 ± 4.1841	41	63.8 ± 1.6954
5 " ...	61	138.0 ± 3.2806	55	113.5 ± 3.2186	30	145.1 ± 6.2511	39	95.0 ± 2.9037
6 " ...	57	182.0 ± 3.8253	53	150.4 ± 3.9542	29	189.9 ± 7.2037	37	117.9 ± 4.0875
7 " ...	55	215.0 ± 4.3483	52	176.8 ± 4.6877	29	221.0 ± 7.4795	37	144.6 ± 6.3557
8 " ...	53	279.4 ± 6.4901	51	215.6 ± 4.7515	29	281.1 ± 12.4629	35	183.6 ± 7.2915
9 " ...	51	369.0 ± 7.1455	50	263.3 ± 7.4112	29	375.3 ± 13.0361	35	209.4 ± 7.6106
10 " ...	51	429.9 ± 7.9667	50	290.1 ± 8.6811	28	431.8 ± 14.4637	31	258.2 ± 9.5072
11 " ...	47	526.5 ± 9.3523	49	355.4 ± 9.9779	28	501.2 ± 15.9263	30	315.8 ± 9.1626
12 " ...	47	602.6 ± 9.3295	49	413.9 ± 10.8482	28	566.2 ± 16.4900	29	359.5 ± 11.4058

TABLE 2

Showing the percentage of mortality of the chicks (during 12 weeks)

LOT NO.	SET			AVERAGE
	1st	2nd	3rd	
	per cent	*per cent*	*per cent*	*per cent*
I	18.51	47.82	20.00	28.78 ± 6.4289
II	18.51	39.13	30.00	29.21 ± 4.1166
III	28.00	30.43	25.00	27.81 ± 1.0592
IV	28.00	47.80	35.00	36.94 ± 3.9130
V	33.33	39.13	25.00	32.48 ± 2.9183
VI	25.92	39.13	25.00	30.02 ± 3.0786
VII	—	52.17	15.00	33.50 ± 12.5356
VIII	43.47	40.74	—	42.11 ± 0.9207

TABLE 3

Showing the amount of feeds charged to the birds in the different lots

LOT NO.	NUMBER OF CHICKS	FEEDS CONSUMED	FEEDS CHARGED PER 100 BIRDS
		kgm.	*kgm.*
I	50	93.9	187.8
II	50	106.1	212.2
III	50	103.0	206.0
IV	44	92.9	211.3
V	47	91.9	195.5
VI	47	88.8	188.9
VII	28	55.5	192.8
VIII	29	51.8	178.9

TABLE 4

Showing the relative cost of producing weanlings in the different lots computed on the basis of 100 birds

LOT NO.	WT. OF 100 BIRDS	VALUE OF 100 BIRDS	COST OF FEEDS	RETURNS ABOVE FEED
	kgm.	*pesos*	*pesos*	*pesos*
I	63.45	38.07	11.65	27.42
II	60.55	36.33	10.72	25.61
III	51.41	30.85	9.81	21.04
IV	59.28	35.57	11.80	23.77
V	60.26	36.16	10.91	25.25
VI	41.39	24.83	—	—
VII	56.62	33.97	10.18 [a]	23.79
VIII	35.95	21.57	— [a]	—

[a] Price of fish meal used was not supplied by the donors of these feeds.

IN MEMORIAM: ANICETO V. ASCALON[1]

It is with deep regret that we make of record the untimely death of Dr. Aniceto V. Ascalon, College Physician and Director of our infirmary. Doctor Ascalon was returning home from a hurried business trip to Manila on December 31, 1935 driving alone in his automobile. Just outside of the municipality of San Pedro Tunasan, Laguna, he collided with a passenger train bound for Manila. Doctor Ascalon was picked up unconscious by his brother who happened to be a passenger on the train. He was rushed to Manila but died on the way, never regaining consciousness. The impact was so severe that it completely destroyed his car.

Doctor Ascalon first joined the College staff as Visiting Surgeon of the College Infirmary on June 16, 1930. He was at this time Director of the San Pablo Municipal Hospital. From June 11, 1932 to December 31, 1932 he was acting director of our infirmary during the time the incumbent Dr. Sixto A. Francisco was on leave abroad. Upon the resignation of Doctor Francisco on March 31, 1933 Doctor Ascalon was appointed his successor as College Physician and Director of the University of the Philippines, Los Baños Infirmary.

During his incumbency the demands on the infirmary grew steadily and it became necessary to undertake extensive improvements to enlarge its capacity. Doctor Ascalon directed this work, but he was not to have the satisfaction of seeing it completed. The name "Infirmary" for our hospital has long been a misnomer, as the skill of Doctor Ascalon invited the handling of the most complicated medical and surgical cases. He was particularly adept in surgery, not a few regarding him as a genius, and was fast earning an enviable reputation as a skillful surgeon not only in Laguna but also in Manila. He was only thirty-three years old at the time of his death.

Doctor Ascalon was a very modest man, never speaking of his work unless questioned. His patients became his most ardent propagandists, however, and his associates who sought his aid in their cases readily became admiring students. He had the true spirit of a humanitarian and followed his profession without regard to its

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[7] General contribution from the College of Agriculture No. 520.

financial returns. It is said of him that he never kept professional accounts and patients paid or not as they saw fit, and never a complaint was heard from him. He even went so far as to give indigent patients money to purchase necessary medicines, and on occasion he is known to have even paid their infirmary accounts.

He readily entered into the spirit of camaraderie at Los Baños and graciously took his share of the many voluntary tasks of a social nature inherent in a live community. He was ever cheerful and an optimist, but he always took his labors seriously and was very realistic in his attitude towards life. He waited on those who sought his aid with skill, interest and patience. These characteristics readily endeared him to all and invited implicit confidence in him. His great popularity was attested by the numerous mourners who attended his funeral on January 6, in San Pablo, Laguna.

The place Doctor Ascalon left vacant in our community will be a most difficult one to fill, and the void in our hearts will, I fear, bear a permanent "tug."

B. M. Gonzalez
Dean, College of Agriculture

RESOLUTION OF CONDOLENCE

Adopted by the Los Baños Chapter, Rizal Center Fraternity
January 30, 1936

WHEREAS, the untimely death of Dr. Aniceto V. Ascalon has filled with grief each member of this organization which he, in life, had honored by his membership; and

WHEREAS, each member feels that he has lost a friend and comrade whose character was so noble; whose heart was so kindly, so generous; and whose code of service and loyalty to duty was so high, that his ideals and his daily life might well be emulated; and

WHEREAS, in his death, the College community has been in so tragic a manner deprived of a loyal and able citizen of unusual promise who gave of himself unreservedly in devoted service in alleviating human suffering; therefore, be it

RESOLVED, that this unanimous expression of sorrow and realization of great loss be conveyed to Dr. Aniceto V. Ascalon's family with assurances of deep sympathy, and also that this organization while mourning its loss is grateful that it was privileged to have on its roster the name of so worthy a man,

That copies of this resolution be sent to the bereaved family; that it be printed in the Philippine Collegian, the Philippine Agriculturist and the Makiling Echo; and be spread upon the minutes of the Rizal Center Fraternity.

A REVIEW: "A GUIDE TO SEXING CHICKS"[1][2]

A number of advantages may be derived from the separation of baby chicks according to sex. This practice not only will prevent disease from overcrowding, it will also prevent losses resulting from keeping an unnecessary number of cockerels in the flock. The mortality among the pullet chicks may also be reduced. The pullets may do better if left to themselves than if cockerels are allowed to remain in the flock.

The Chinese who have been hatching eggs on a commercial scale for many centuries separate the baby chicks according to sex before these are sold to the farmers. On this subject, King[3] in his *Farmers of Forty Centuries* wrote: "After the chickens have been hatched sufficiently long to require feeding they are ready for market and are then sorted according to sex and placed in separate shallow woven trays thirty inches in diameter. The sorting is done rapidly and accurately through the sense of touch, the operator recognizing the sex by gently pinching the anus."

Many years after this book had been published, which was in 1925, two Japanese investigators, Doctors Kiyoski Masui and Juro Hashimoto, discovered (or rediscovered?) that a minute genital eminence is present in the cloaca or anus of chicks and they used this character as a means of determination of the sex of baby chicks. This rediscovery, however, was not put into extensive practice until several years later. According to the story, one Kojima, an impoverished Japanese poultryman, worked for three years with "astonishing pertinacity . . . mostly at night, training himself in the art of sex determination." This method which has been put into practical application by Kojima has aroused the interest of poultrymen in the United States, Canada, England, France and Germany. In these countries, training centers for chick sexing have already been established.

During the last three years, numerous magazine articles have been published on this subject in the United States and in England.

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[1] General contribution from the College of Agriculture No. 521. Received for publication February 5, 1936.

[2] GIBBS, CHARLES S. 1935. A guide to sexing chicks. 63 p., 20 fig. New York: Orange Judd Publishing Company, Inc. Price $1.25.

[3] KING, F. H. 1911. Farmers of forty centuries. x + 441 p., 248 fig. Madison, Wis.: Mrs. F. H. King.

A number of books have been written to serve as guides in sexing chicks. The first of these is a translation of a small book by Doctors Masui and Hashimoto published some time in 1933.[4]

One of the most recent additions to the literature on chick sexing is Doctor Gibbs' little book, *A Guide to Sexing Chicks.* The author, now a research professor of Veterinary Science in Massachusetts State College, U. S. A., "was a member of the faculty of the College of Agriculture and Forestry, University of Nanking, China, during the period that Drs. Masui and Hashimoto discovered and gave to the world the art of sexing chicks." According to Doctor Gibbs, he also had the good fortune to attend a series of lectures on the subject by Doctor Masui and of seeing Mr. Kojima demonstrate the art before a group of Japanese student-farmers.

The book, *A Guide to Sexing Chicks,* is divided into four chapters: Chapter I, General Considerations; Chapter II, General Technique; Chapter III, Special Technique; and Chapter IV, General Conclusions. Although the subject of chick sexing is thoroughly discussed in these four chapters, the author very wisely cautions the reader in these words: ". . . . it is possible for a person to acquire the necessary scientific knowledge of chick sexing and still be unable to use it to advantage, because of the lack of skill." "Skill", the author adds, "is born in a person and can not be acquired by either study or demonstration."

To be a successful chick sexer, Doctor Gibbs tells us in Chapter I: "The vision should be clear, the eye accommodation rapid, and the eyes strong enough to withstand the glare of a bright light without tiring. The hands should not only be steady, but small, soft and pliable, and fingers nimble." Further on, he states: "He should be kind in disposition, gentle in manner, with a natural liking for chickens, and withal a keen interest in the application of biologic science to the welfare of the poultry industry."

In the next two chapters, the author calls attention to good light as essential to chick sexing. The importance of artificial light is pointed out, and a 200 watt electric bulb with the tip frosted, and fitted with a proper reflector is suggested. We are told that two methods are used in sexing, one depending mostly upon the "process" and the other largely upon the appearance of the wrinkles of the mucous membrane of the cloaca. Both methods are described in detail in the book. The correct holding of the chick and the proper identification of the male and female processes of which there are a number of kinds among baby chicks are discussed fully. The illustrations that accompany these two chapters are of real educational value, especially to the beginner in chick sexing.

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[4] MASUI, K., AND JURO HASHIMOTO. 1933. Sexing baby chicks. 99 p., 77 fig. Vancouver, Canada: Journal Printing Co., Ltd. Price $5.00.

The author concludes that to get the practice that is necessary to attain a satisfactory degree of efficiency to use in chick sexing for commercial purposes, "5,000 chicks is none too many for the beginner to have handled, sexed, and checked for accuracy." Chick sexing is now a recognized profession in Japan where licenses are granted to three classes of chick sexers, depending upon their degree of accuracy and speed.

Indeed, this book, priced to be within the reach of poultry raisers, would be a valuable guide to poultrymen interested in the art of sexing chicks. It would be of particular value where expert assistance in this work is not obtainable. As Doctor Gibbs points out, although some poultrymen will have nothing to do with this work, as chick sexing is both a difficult and a disagreeable task to perform, "others have found it profitable and are determined not to give up." It appears, no matter what the individual attitude towards it may be, that chick sexing has come to stay in the poultry world.

F. M. FRONDA
Of the Department of Animal Husbandry

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: XIII [1]

B. M. GONZALEZ
Dean, College of Agriculture

A true measure of the stability and progressiveness of a country lies in its ability to foresee its problems and study their solution before they become too pressing. Contrast with this the situation of stagnant governments which depend entirely on experience and intuition and the pressure of need for immediate action as guides in the solution of their problems.

The Philippine Commonwealth is to be congratulated for having the most progressive and the best organized College of Agriculture in the tropics within its confines. We owe this to the initiative of Americans who early realized the utter dependence of the country on its agricultural resources for its national welfare. How the College is acquitting itself in its allotted task may be judged from a perusal of the subjects listed in this thirteenth list of contributions from its staff. We hope it will be possible to continue the present pace of work in the institution, if not actually to increase it with more adequate support. It will be most unfortunate if the country has to fall into a vicious circle by penalizing progress in the interest of immediate needs. Our statesmen should appreciate the existence of a research center so close at hand which can serve as the nucleus for more extensive and intensive development of similar activity along other lines of endeavor, so necessary in an "up-and-coming" nation.

II. EXPERIMENT STATION CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1–199, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, 1923. For Nos. 200–287, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 288–354, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 355–440, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 441–517, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 518–595, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March,

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[1] General contribution from the College of Agriculture No. 522.

1929. For Nos. 596–643, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 644–710, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 10, March, 1931. For Nos. 711–799, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 800–880, *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933. For Nos. 881–948, *see* THE PHILIPPINE AGRICULTURIST XXII, No. 10, March, 1934. For Nos. 949–1021, *see* THE PHILIPPINE AGRICULTURIST XXIII, No. 10, March, 1935.

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(1099) Manresa, Miguel, and B. M. Gonzalez. 1936. Studies on surra: IV. Variability in size of the trypanosomes and density of infection, acquired and natural immunity. The Philippine Agriculturist 24: 716–751. *Charts 1–3.*

(1100) Espino, Rafael B. 1936. Construction of mushroom beds in the Canton region. The Philippine Agriculturist 24: 752–762. *Fig. 1–8.*

(1101) Dalid, Banao. 1936. Protein supplements in poultry rations: VII. Comparative studies on the influence of various kinds of fish meals in rations for chicks. The Philippine Agriculturist 24: 872–882. *Chart 1.*

(1102) Teodoro, A. L., A. B. Catambay, E. K. Ongsansoy, and J. P. Mamisao. 1936. Alcohol and alcohol-gasoline blends as fuels for automotive engines: IV. Performance characteristics of alcohol, alcohol-gasoline mixtures, and gasoline as motor fuels under different road conditions. The Philippine Agriculturist 24: 763–775. *1 map and 1 chart.*

(1103) ALDAMA, MARCOS J. 1936. Some preliminary studies, under field conditions on the propagation by stem cuttings of three species of Derris. The Philippine Agriculturist 24: 776–794. *Fig. 1–4; charts 1–2.*

(1104) MARCOS, JULITO. 1936. A comparative test of ratoon canes of some College seedlings and two commercial varieties of sugar cane. *Abstract in* The Philippine Agriculturist 24: 795–796.

(1105) NATINO, FELIX N. 1936. The variability in yield of individual coffee trees at the College of Agriculture. *Abstract in* The Philippine Agriculturist 24: 797–798.

(1106) OCFEMIA, G. O., I. C. MANZO, AND MARTIN S. CELINO. 1936. The gum disease of citrus occurring in the Philippines. The Philippine Agriculturist 24: 811–838. *Fig. 1–8.*

(1107) TEODORO, A. L. 1936. Alcohol and alcohol-gasoline blends as fuels for automotive engines: V. Studies on the performance of an eight-cylinder engine using gasoline, dehydrated alcohol, and dehydrated alcohol-gasoline mixtures. The Philippine Agriculturist 24: 839–853. *Charts 1–7; fig. 1.*

(1108) VILLANUEVA, L. J., AND H. E. LUMANG. 1936. Carbon-nitrogen ratios of some Philippine soils. The Philippine Agriculturist 24: 854–862. *Fig. 1.*

(1109) RIVERA, TEOFILO B. 1936. A further study of the comparative feeding value for growing pigs of coarse and standard rice bran. The Philippine Agriculturist 24: 863–871.

(1110) DALUPANG, DONATO G. 1936. The effect upon the yield and quality of tobacco of transplanting different ages of tobacco seedlings. *Abstract in* The Philippine Agriculturist 24: 898–899.

(1111) OPEÑA, PANTALEON P. 1936. Studies on propagation of three shade trees for coffee in the College of Agriculture at Los Baños, Laguna, Philippine Islands. *Abstract in* The Philippine Agriculturist 24: 899–900.

III. GENERAL CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1–104, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, December, 1923. For Nos. 105–141, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 142–164, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 165–184, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 185–203, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 204–216, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 217–266, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 267–288, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 10, March, 1931. For Nos. 289–308, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 308–348, *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933. For Nos. 349–397, *see* THE PHILIPPINE AGRICULTURIST XXII, No. 10, March, 1934. (No. 398 omitted in the following list, *see* note, March, 1934). For Nos. 399–477, *see* THE PHILIPPINE AGRICULTURIST XXIII, No. 10, March, 1935.

(478) PENDLETON, ROBERT L. 1935. Ipil-ipil—A profitable crop for some of the now idle sugar cane lands. Sugar News 16: 133–142. *Fig. 1–15.*

(479) MANRESA, MIGUEL M. Preparing Aggie students for research activity. The Philippine Collegian, October 10, 1934.

(480) PENDLETON, ROBERT L. 1935. Added evidence of the importance of ipil-ipil (*Leucaena glauca*) for Philippine sugar cane plantations. Sugar News 16: 194–195.

(481) SACAY, FRANCISCO M. 1935. Vocational education in agriculture: I. The place of vocational education in our system of secondary education. Philippine Journal of Education 18: 588–589.

(482) ESPINO, RAFAEL B. As science is remaking the world so the agriculture graduates will assume leadership. Philippines Herald, April 11, 1931.

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(484) FRONDA, F. M. 1935. Chickens once called Cantonese. Agricultural Life 2: p. 17, 18, 24, and 26.

(485) ESPINO, RAFAEL B. 1934. Consultation on farm problems. Agricultural Life 1: 23–24.

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(487) BUENAVENTURA, TEODOSIO. The new régime. The Tribune, July 28, 1935.

(488) BUENAVENTURA, TEODOSIO. Looking ahead. The Critic, July 15, 1935.

(489) ARAGON, VICENTE B. 1935. Uses and preparation of some annual farm crops products. The Stockman and Farmer 2: (12): p. 10 and 11.

(490) GONZALEZ, B. M. 1935. The researcher in the natural sciences. The Philippine Agriculturist 24: 1–4.

(491) VILLEGAS, VALENTE. 1935. The Red Scindi cattle imported by the College of Agriculture, University of the Philippines. The Philippine Agriculturist 24: 16–21. *Fig. 1–2.*

(492) GONZALEZ, L. G. 1935. Note: Secretary's report on Los Baños Biological Club for 1934–35. The Philippine Agriculturist 24: 76–78.

(493) PENDLETON, ROBERT L. 1935. Soil surveys, classification and mapping in the Philippines. National Research Council of the Philippine Islands Bulletin 6: p. 590–594. (Annual Report 1934-1935.)

(494) PENDLETON, ROBERT L. 1935. Here and there in Southern, Central and Northern Luzon. From the notebook and camera of a soil technologist. The Philippine Agriculturist 24: 89–103. *Fig. 1–3.*

(495) YULE, EMMA S. 1935. E. Gertrude Madison: In memoriam. The Philippine Agriculturist 24: 166–167.

(496) TEODORO, A. L. 1935. Alcohol as a motor fuel. Agricultural Life 2: 10–11.

(497) GONZALEZ, B. M. 1935. Richard Morris Holman: In memoriam. The Philippine Agriculturist 24: 249–250.

(498) ESPINO, RAFAEL B. 1935. Robert L. Pendleton: An appreciation. The Philippine Agriculturist 24: 337–339.

(499) **Espino, Rafael B.** 1935. Plant physiology as a foundation of scientific agriculture. Lingnan Biology Seminar Reports. (Lingnan University, Canton.)

(500) **Uichanco, Leopoldo B.** 1935. The Philippines in the world of science. National Research Council of the Philippine Islands Bulletin 3: p. 205–217.

(501) **Uichanco, Leopoldo B.** 1935. A historical résumé of Philippine entomology. National Research Council of the Philippine Islands Bulletin 5: p. 472–480.

(502) **Capinpin, Jose M.** 1935. History of plant breeding in the Philippines. National Research Council of the Philippine Islands Bulletin 5: p. 457–471.

(503) **Fronda, F. M.** 1935. How to raise poultry for profit. The Stockman and Farmer 2: August, p. 3, 30; September, p. 14–15.

(504) **Espino, Rafael B.** 1936. Impressions from a recent trip to China. The Philippine Agriculturist 24: 619–623.

(505) **Yule, Emma Sarepta.** 1935. In Japan: Without clock or calendar. iv + 269 p., 37 illustrations. Boston: The Stratford Company.

(506) **Buenaventura, Teodosio.** The garments of civilization. The Tribune, October 27, 1935.

(507) **Basio, E.** 1935. Fireless or cold brooding of chicks. Philippine Poultry Journal 5: p. 5, 6. (February)

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(509) **Espino, Rafael B.** 1935. Farming in South China. Agricultural Life 2: p. 14 and 33. (December)

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(511) **Manresa, M., and B. M. Gonzalez.** 1935. Replica de dos cientificos al Dr. Buencamino. Lunes, 18 de Marzo, 1935.

(512) **Fronda, F. M.** 1935. The hen as a food producer. Agricultural Life 2: p. 33, 34, and 35. (March)

(513) **Uichanco, L. B.** 1935. The call of the farm. The Anti-Usury Bulletin Vol. 1, No. 5: p. 11 and 24. (December)

(514) **Aquino, Dionisio I.** 1935. Robert L. Pendleton: An appreciation. Sugar News 16: 365–366.

(515) **Cole, Anna F.** Teaching methods. University of the Philippines President's Committee on the Improvement of Teaching Bulletin, July, 1935.

(516) **Gonzalez, Leon G.** A survey of the most effective method of teaching in the College of Agriculture. University of the Philippines President's Committee on the Improvement of Teaching Bulletin, July, 1935.

(517) **Baltazar, Eulalio P.** 1935. Commercial groups, species, types and varieties of cotton and their special uses. Agricultural Life, 2: p. 11–14, 29, (July)

(518) **Calma, Valeriano C.** 1935. Industrial parade in traditional College of Agriculture celebration. Agricultural Life 2: p. 13 and 36.

(519) **Uichanco, Leopoldo B.** 1936. Ourselves as Gullivers in the Lilliputian world of the insects. The Philippine Agriculturist 24: 805–810.

(520) **Gonzalez, B. M.** 1936. In memoriam: Aniceto V. Ascalon. The Philippine Agriculturist 24: 883–884.

(521) **Fronda, F. M.** 1936. A review. "A guide to sexing chicks." The Philippine Agriculturist 24: 885–887.

(522) **Gonzalez, B. M.** Are we headed for starvation? The Philippines Herald Year Book, November 1, 1935; p. 51 and 91.

(523) **Gonzalez, B. M.** 1936. Published contributions of the College of Agriculture: XIII. The Philippine Agriculturist 24: 888–897.

IV. CIRCULARS

The circulars are numbered serially as reported. For Nos. 1–5, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 6–11, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 12–14, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos. 10–16, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March, 1929. For Nos. 17–18, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 19–21, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 22–24, *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933. For No. 25 *see* THE PHILIPPINE AGRICULTURIST XXII, No. 10, March, 1934. For Nos. 26–28, *see* THE PHILIPPINE AGRICULTURIST XXIII, No. 10, March. 1935.

No. 10. (Revised) —**David, Pedro A.** 1935. Practical directions for coffee planting. 40p., 23 fig.

V. MISCELLANEOUS CONTRIBUTIONS

(From outside the College and translations)

The contributions are numbered serially as reported. For Nos. 1–6, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932. For Nos. 7–10, *see* THE PHILIPPINE AGRICULTURIST XXI, No. 10, March, 1933. For No. 11, *see* THE PHILIPPINE AGRICULTURIST XXII, No. 10, March, 1934.

(12) **Yutuc, Lope M.** 1935. Observations on the occurrence of surra in Laguna Province. The Philippine Agriculturist 24: 104–110.

(13) **Pendleton, Robert L.** 1936. The Third International Congress of Soil Science: From a notebook of a soil technologist. The Philippine Agriculturist 24: 709–715.

(14) **Benemerito, A. N.** 1936. Mushroom culture in Canton. The Philippine Agriculturist 24: 624–634. *Fig. 1–8.*

ABSTRACTS [1]

The effect upon the yield and quality of tobacco of transplanting different ages of tobacco seedlings. DONATO G. DALUPANG. (*Thesis presented for graduation, 1934, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 488; Experiment Station contribution No. 1110.*)—The object of this study was to determine the effect upon the yield and quality of tobacco of transplanting seedlings at different ages.

The work was conducted in the College of Agriculture Experiment Station from June, 1932 to May, 1933.

One of the standard native varieties in the Cagayan Valley, N-45 Alafug, was used in the study.

There were four experimental cultures:

Culture No. 1.	51-day-old seedlings
Culture No. 2.	44-day-old seedlings
Culture No. 3.	37-day-old seedlings
Culture No. 4.	30-day-old seedlings

The cultures received the same treatment or care from seedling stage to matured plants.

Fifty plants were taken at random from each culture before harvesting the leaves and these plants were studied according to the following: (1) height of the individual plant; (2) length and width of the lowest, standard and upper leaves; (3) number of the sand, standard and top leaves; (4) texture, color, surface venation, petiole, position of leaves on stem and percentage of injury caused by mosaic, by tobacco wilt disease and, by tobacco borer infestation.

The following results were obtained by the author. (1) At maturity there was an ascending order in the height of the plants from the older to the younger seedlings.

(2) The younger seedlings produced longer and broader leaves than the older ones.

(3) In general, the number of standard and top leaves produced from 30-day-old to 51-day-old seedlings decreased with increase in age.

(4) The plants matured in the descending order from the older to the younger seedlings.

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[1] Abstracts presented as part of required theme work in English 3a, College of Agriculture.

(5) The 30-and 37-day-old seedlings gave higher yield of dry leaves than either the 44- or 51-day-old seedlings.

(6) In quality of leaves produced, the 30-day-old seedlings ranked first, the 37-day-old, second, and the 44-and 51-day-old, third.

(7) The 30-, 37-, and 44-day-old seedlings produced leaves that were of the same gumminess, pubescence and thickness. The 51-day-old seedlings produced thicker and slightly gummier leaves than any of the other three cultures.

(8) The age of the seedlings did not affect the character of the surface, venation, petiole, position or arrangement of leaves on the stem.

(9) The plants of 51-day-old seedlings were the most susceptible to mosaic and tobacco wilt disease and to tobacco borer infestation.

(10) The author concluded from his study that on the whole, the 30-day-old and 37-day-old seedlings produced larger yields and a better quality of leaves than either the 44-day-old or 51-day-old seedlings.

—Abstract by Bonifacio Puntalba

Studies on propagation of three shade trees for coffee in the College of Agriculture at Los Baños, Laguna, Philippine Islands. PANTALEON P. OPEÑA. (*Thesis presented for graduation, 1935, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 489; Experiment Station contribution No. 1111.*)—The author worked on the propagation by seeds and by cuttings of shade trees for coffee plants, using three species of leguminous plants; namely, *Gliricidia sepium* (Jacq.) Steud., *Erythrina indica* Lam. and *Leucaena glauca* (Linn.) Benth. Stem cuttings approximately 3 to 4½ cm. in diameter and 30, 60, 90 and 120 cm. in length were prepared monthly from each species. Seeds of these species were gathered and stored in paper bags under laboratory conditions. Monthly plantings of 25 cuttings of each size and 100 seeds of each species were made under field and nursery conditions.

The investigator reported the following results:

1. *Erythrina indica* Lam., *Gliricidia sepium* (Jacq.) Steud, and *Leucaena glauca* (Linn.) Benth. can be propagated either by cuttings or seeds as shade trees for coffee.

2. Seeds of *Erythrina indica* and *Gliricidia sepium* when planted one and one-half or two years before the coffee, and *Leucaena glauca* when planted more than two years before, attained a height of more than two meters and afforded enough shade for the coffee.

3. Cuttings of *Erythrina indica* 30, 60 and 90 cm. long when planted six months before the coffee, of *Gliricidia sepium* 60 cm. long planted nine months before, and of *Leucaena glauca* 90 cm. long planted one and one-half years before would furnish one square meter of shade. But cuttings 120 cm. long from these species when planted one and one-half years before planting the coffee would afford more than two square meters of shade.

4. Under Los Banos conditions, the best time to plant cuttings was found to be in June and July; to plant seeds, June to August.

5. In the field, it cost ₱9.95 to collect, prepare and plant 1,200 seeds and 3,600 cuttings at 6 by 3 meters; in the nursery, ₱11.00.

6. For economy in transportation and materials, cuttings of *Erythrina indica* should be prepared as short as 30 cm., *Gliricidia sepium*, 60 cm. long and *Leucaena glauca*, 90 cm. All the cuttings should be 3.5 to 4.5 cm. in diameter.

7. Seeds from *Gliricidia sepium* lost their viability within seven or eight months after harvesting; *Erythrina indica* and *Leucaena glauca* retained their power of germination even after one year.

—Abstract by Felix N. Natino

CURRENT NOTES

More than 1,800 lots of seed from drought-resistant plants brought back from Turkestan by explorers of the U. S. Department of Agriculture are now growing in the plant reserve stations established last year by the department. Additional lots of seed have recently arrived from Manchuria and Mongolia, and still other valuable shipments are expected after the expedition now working on the edge of the Gobi Desert has had an opportunity to harvest the seeds which will ripen this fall.

An expedition headed by Professor Nicholas Roerich was sent to the areas bordering the Gobi Desert because of the great pasture areas which apparently withstand the heat of summer, the cold of winter and the scanty rainfall. Through centuries of natural selection strains of grasses and legumes which are able to cope with these conditions have developed and increased.

—*Science*, July, 1935

With reference to the magnitude of trade coconuts, copra, coconut oil, coir and coconut cake are important products. During the last four to five years the Indian consumption of nuts has increased rapidly. This is partly accounted for by the fall in the prices of nuts and the consequent attempt on the part of the producer to dispose of his produce in the most remunerative manner. When the price of copra is low the producer is able to realise more money by disposing of the nuts as whole nuts for edible purposes.... India imports annually about 12 million nuts from foreign countries.

The Tropical Agriculturist, April, 1935.

It is announced from Zurich that androsterone, the male sex hormone, has been prepared artificially. Even in an age of scientific marvels this is a notable achievement. The nature of hormones, those queer traffic directors of the living body, is still imperfectly understood; for the most part hormones are obtained only with great difficulty. Hitherto, such as have been extracted, have found application mainly in medicine; there are others for which conceivably economic use in other directions may shortly be found—fecundity in fowls and lactation in mammals are apparently both controlled by secretions of ductless glands. The imagination is apt to run riot with the contemplation of what *may* follow from the synthesis of a typical hormone. Practical results do not always follow scientific advances of course. Many laboratory discoveries remain for generations mere academic "exhibits." It may be that such a fate awaits this particular discovery. None the less the observant will store it in the "matters pending" file of memory. *Journal of the Ministry of Agriculture, England, December, 1934.*

Reprinted in *The Journal of the Jamaica Agricultural Society,* March, 1935.

The soy bean crop is probably the most remunerative a farmer could sow. Its cultivation would give great employment.

The Farmers' Gazette, (Ireland) July, 1935.

Chitin, which is found practically throughout the invertebrate animal world, forms such things as the wings and body-shells of insects and the thick crusty armor of crabs and lobsters. It contains carbon and hydrogen in about the same proportions as they are found in cellulose, but it has less oxygen than cellulose has, and it also contains nitrogen which cellulose lacks, and is to that extent chemically more nearly related to the proteins than to the carbohydrates.

But it is as susceptible as cellulose to chemical manipulation, and if industrial chemists were sufficiently interested could doubtless be converted into many of the same things that now are born from cellulose, such as synthetic fabrics, lacquers, plastics, transparent wrappings. Little has been done with chitin even by laboratory chemists; nothing, apparently, with a view to possible commercial applications.

There is no lack of raw material. The lobster, crabmeat and shrimp packing industries turn out mountains of discarded shells every season, which are now just plain waste.... Another possible source of chitin, if it ever becomes a paying proposition, are the insect traps set in orchards, nurseries and other places where the value of trees and shrubs justify the expense of maintaining them.

Science, March, 1935.

Letters by George Washington show that he recognized the bad effects of soil erosion on his own farms and took steps to "bind together and prevent the earth from gullying."

Science News Letter, January, 1935.

COLLEGE AND ALUMNI NOTES

Dean Koo Kwai Fan of the College of Agriculture, Lingnan University, Canton, China was a Campus visitor during the Christmas recess. He arrived on December 22, 1935 accompanied by Mr. Hon Yu Huen of the Animal Husbandry Department of the Bureau of Agriculture and Forestry in Canton. They were guests of Dr. and Mrs. R. B. Espino, while on the Campus. On the evening of their arrival, they were honor guests at a buffet dinner given by Doctor and Mrs. Espino. Among the guests invited were several faculty members and their wives and all the Chinese students in our College.

Accompanied by Doctor Espino and some of the Chinese students, Dean Koo and Mr. Hon motored through the provinces of Laguna, Tayabas, and Batangas, observing coconut, sugar cane and other plantations. They also visited various departments of the College. After leaving the Campus, they visited the Bureau of Plant Industry in Manila and some of its Experiment Stations. Mr. Hon spent most of his time in the Bureau of Animal Industry observing methods of preparing rinderpest serum.

When they sailed on January 5, 1936, Dean Koo and Mr. Hon, took with them besides the memory of their observations and experience a large number of bulletins and other publications and 26 sacks of coconuts, one boar for breeding purposes, and several crates of planting materials.

Mr. Charuña Suebsaeng '28 was a welcome Campus visitor on December 20, 1935. He brought us good tidings from our other Siamese graduates almost all of whom are employed in agricultural schools or the Department of Agriculture and Fisheries. Mr. Suebsaeng was employed in soils work at the time of the revolution in Siam. He was interested in the establishment of the constitutional government and was appointed by the King as a senator in the Siamese National Assembly. Later, he felt that his training and education called him to work in the Department of Agriculture and Fisheries, so he resigned from the law-making body. His visit to the Philippines was his first stop on an extended tour for observation and study of the cotton industry from the viewpoint of both the culture and the manufacture. He is sent on this most important work by the Department of Agriculture and Fisheries of which Mr. Thongdee Resananada '24 is the Director. According to present plans, Mr. Suebsaeng will spend three years in studying the cotton industry in the United States, South America, China and Japan.

Dr. Francisco Villaruz has been appointed Physician and Director of the U. P. Los Baños Infirmary. Doctor Villaruz was graduated from the College of Medicine, Sto. Tomas University, Manila in 1927. He studied in the University of Paris from 1927 to 1929. His experience includes about two years practice in Bilibid Prison and Iwahig Penal Colony. In the colony he was Chief Physician and Surgeon. In 1932 he resigned from the Bureau of Prisons and entered private practice.

The College community is fortunate in securing the services of a physician with the training and the experience of Doctor Villaruz for the position made vacant by the tragic death of Doctor Ascalon.

Miss Felicidad Chan '35 now on the staff of the Batac Rural High School, Ilocos Norte spent two days on the Campus in February getting information and literature on her work. Miss Chan teaches the subject, Plant pests and diseases and is in charge of the silk culture work.

Miss Chan and Miss Torres '34 are the only two women teaching scientific subjects in the Philippine Farm Schools.

At the quarterly meeting of the Philippine Mechanical and Electrical Engineers held in the evening of November 14, 1935, Dr. A. L. Teodoro, Head of the Department of Agricultural Engineering was the principal speaker. Doctor Teodoro spoke on the use of alcohol as a motor fuel, a topic on which he can speak with authority as he has made it a subject of special intensive research for the past several years. The results of his work in association with the Calamba Sugar Estate have been published in a series of five articles in THE PHILIPPINE AGRICULTURIST, the fifth appearing in this issue. Report says that Doctor Teodoro ably held his own in the earnest and rather heated discussion that followed his address.

The Rancher's Club, filling two buses, went on a trip to Lipa, Batangas on December 15, 1935. The students visited the stud belonging to Mr. Santos Sarmiento, the Rose Packing Co., a ham and sausage factory owned and operated by Dr. Manuel L. Roxas, a member of the first graduating class from this College, and the Lipa Poultry and Dairy Farm owned by Mr. Leon Katigbak. Mr. Sarmiento's stud horse is "Kulut", the sire of many prize winners at the San Lazaro Hippodrome, Manila, and himself a prize winner at the Live Stock Show at the Laguna Provincial Fair held at the College of Agriculture eleven years ago. The Lipa Poultry and Dairy Farm is managed by Mr. Porfirio Barlaan '35. In the dairy, are Indian buffaloes, the foundation stock of which were bought from the College of Agriculture.

The Club made a flying visit or rather a call at the Tanauan Citrus Station and the Lipa Coffee-Citrus Station of the Bureau of Plant Industry. It was a privilege and a pleasure to see the many varieties of citrus in heavy fruiting just before harvest time.

At noon on December 24, the faculty and employees of the College of Agriculture through the Social Affairs Committee entertained the students who remained on the Campus over the Christmas recess at a "lechon" luncheon in Molawin Hall. There were about two hundred student guests. College songs and especially the Christmas carols played by the College Orchestra added much to pleasure of guests and hosts. And the broadcast over KZEG dedicated to the College was much enjoyed and warm appreciation of the generosity of the Station was expressed. After the students had gathered at their places at the tables, they sang, led by the orchestra, "Auld Lang Syne" before sitting down and "falling to".

Some twelve members of the faculty were present as hosts. One of the College women students, Mrs. Crispin Dacanay voluntarily gave much efficient help in serving. This service is outstanding and encouraging to the Committee. The orderliness and courtesy of the students is a matter of great pride to the hosts. May we add that it is to the whole College.

The Standing Committee on the Baker Memorial Scholarship award met on November 29, 1935. This committee is composed of the Dean of the College and the Secretary, both *ex officio* members and a third member who shall be head of a department. The third member is selected automatically by an adopted routine. This year this third member was Dr. G. O. Ocfemia, head, Department of Plant Pathology.

By the conditions adopted by the faculty this award which is the year's interest on the Baker Memorial Scholarship Fund is awarded to one or more self-supporting students in the senior class. The basis of selection is "character, promise of future usefulness and scholarship." Of these three qualities the second is the most important.

After due consideration of applications, the Committee divided the award which amounted to ₱100 equally between Felix Salcedo and Flaviano Olivares. Salcedo was graduated from the Central Luzon Agricultural School in 1930. The average of his scholarship rating to the end of the first semester of this academic year was 2.50. He was posted for marked distinction in scholarship at the end of first semester in 1934-35. He has been employed in the Department of Agricultural Education from October, 1930. He has held elective offices in the Student Body. He was recently elected to membership in the honorary society, Phi Kappa Phi.

Olivares is a graduate from Manila West High School. The average of his scholarship rating to the end of the first semester of the present academic year was 2.83. He has been employed in the

Library as a student laborer since the first semester of his enrollment in the College. He has held elective offices of trust in the Student Body; has been an active member of the Mimics; having a good singing voice he was assigned the part of the Mikado in the presentation of the "Mikado" in 1932. His success in the rôle is well remembered. In different plays his was a leading part. He held the commission of Lieutenant Colonel in the Los Baños Corps of Cadets.

The reports on these young men show most forcibly that the self-supporting student can take a normal part, if he desires, in Campus activities if not in the social gayety.

Congratulations are extended to these two young men. It is hoped that this achievement is an earnest of their usefulness as citizens of the Philippines.

IN MEMORIAM

Toribio Vibar, B. Agri. 1912; B.S.A., 1921; M.S., 1921; Ph.D. (Univ. Ill.), 1923.

Teacher, Bureau of Education 1912-1918. Instructor in Agronomy, College of Agriculture, August 27, 1918– June 30, 1921; Assistant Professor in Agronomy, July 1, 1921– October 31, 1928. Resigned. Supervisor of Agricultural Instruction, Bureau of Education, 1929–1930. Chief of the Division of Agricultural Experiment Stations in the Bureau of Plant Industry, April 1, 1930– January 1, 1932; Chief Agronomist in the Phytological Research Division, January 1, 1932–December 31, 1933. Retired on December 31, 1933 under Reorganization Act of 1932. Editor and Publisher, *Agricultural Life* 1934—

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